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Button-free Micro Recorder

A new micro recorder that turns on at the sound of your voice may revolutionize the entire personal recording industry.

The idea is simple yet the results are very dramatic. Olympus, the famous precision camera company, has developed the world's first voice-activated micro cassette recorder—the Olympus SD.

RECORD WITHOUT BUTTONS

The unit has an optional voice activation switch (VA switch) that automatically turns on your recorder at the sound of your voice. If you drive in your car or do dictation in your office, just talk to your unit. It does the rest. It will turn on to record your comments and turn off when you stop talking.

The VA switch has a three-position sensitivity control. You can set it for low sensitivity while driving your car so only the close proximity of your voice will turn it on. In the middle sensitivity position, you could use the unit in conferences or for dictation in your office. In the high sensitivity position, you could even leave the unit in your desk and it would record all the sounds in your office—perfect for private detectives.

The VA switch has other advantages. It makes your tapes more efficient by making them last longer since your unit turns off during long pauses. So the unit's sixty minute tapes might be the equivalent of seventy or eighty minutes on other systems.

ACCESSORY MODULES

The VA switch is one of a series of small modules that plug into the bottom of the SD, thus expanding the recording system. These modules include an AM or FM radio module that plays music and news directly into your unit, a power amplifier and speaker that play back your tapes with high fidelity for conferences or personal music enjoyment, a telephone pick up that will record both sides of a phone conversation and a clip-on microphone for conferences or speeches. There are also a separate transcriber, foot pedal and headset available for your secretary.

MOTOR DRIVE BREAKTHROUGH

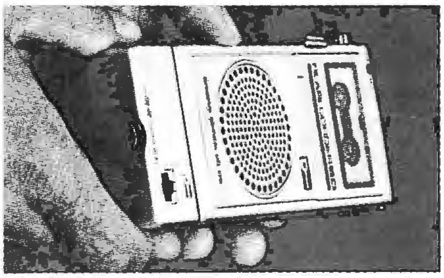
The Olympus SD has several new recording breakthroughs. The first is the new coreless motor. Conventional motors require a wire-wound long, solid core. In the Olympus coreless motor, the windings are on the outside or stationary part of the motor making it flatter, yet it has greater initial torque and more consistent speed than any conventional unit. Because of the coreless design, the entire SD unit is lighter, flatter, and easier to carry. There is less vibration, noise and power consumption so your batteries last longer and your recordings sound cleaner.

RECORDING HEAD QUALITY

The unit uses ferrite for its recording heads—the same material used in precision studio recorders. This extremely hard, diamond-like material will never wear out and prevents oxide build-up on the heads. You have top recording quality without wear.

NEW MICROPHONE TECHNOLOGY

The new built-in electret condenser microphone with automatic level control is also a major design advance. Through new electronic circuitry, the impedance of the microphone remains constant, thus passing on the natural sound quality of all frequencies without distortion. The result is a clear recording with an extremely low signal to noise ratio so you won't hear objectionable background hissing or humming.



Just plug in the VA switch and you can operate the SD without pressing its record and pause controls. The basic unit measures only 7/8"x 2½"x 5½" and the VA switch adds another inch to its length.

VERY RUGGED UNIT

With all its quality and breakthrough features, the Olympus did not lose touch with reality—namely, that personal recorders get dropped, stepped on and damaged. Even if you're careful, there's always a chance you may drop or damage your unit.

The Olympus SD was built with both special cushioning features and component design that literally permit you to abuse your unit while still maintaining the same recording quality. The most sensitive component has always been the motor. If a conventional unit is dropped, even a slight motor core misalignment will noticeably affect performance. With the Olympus SD motor, there is no core, so core misalignment is impossible. Olympus also maintains a prompt service-by-mail facility if service should ever be required. Just slip your 12 ounce recorder in its handy mailer and it's on its way. Service should never be required but it's always good to know that your unit is solidly backed by a responsible service organization.

AUTO SHUT-OFF

Some units have automatic shut-off at the end of a cassette during the record mode. So does the SD. But the SD also has this feature on playback, thus preventing tape stretching and battery waste. And when the unit does shut off, it's practically silent and does not attract attention.

QUALITY FEATURES

The tape is capstan driven—the best drive available in cassette recorders. It can play eleven hours on a set of two penlight batteries and optional rechargeable batteries are also available. The Olympus sixty minute cassette (30 minutes per side) costs only $2.99 compared to $4.99 and $5.99 for other brands. This gives you the lowest cost per minute recording of any system available.

JS&A offers you the most important breakthrough product in micro cassette recording. Olympus' voice activation switch, its new coreless motor, ferrite tape heads and electret microphone mean both quality, value and advanced technology—years ahead of all others. And the price of the Olympus SD is actually less than many of today's more popular brands that do not yet have the SD's innovations.

Olympus is the company that invented the micro recorder in 1969. Since then, they have licensed dozens of other companies to produce them—yet no unit compares with the Olympus. JS&A is America's largest single source of space-age products and a company that has brought to market the most advanced new products of this decade. We feel the SD is one of them.

But don't take our word for it. We suggest you order just the Olympus SD and the VA switch. Then use the system for thirty days. Take it with you to work, keep it in your pocket when you travel, and use it to dictate your notes. Compare the Olympus to every other unit on the market and read all the consumer reports on recording devices. Then after thirty days, decide whether or not the Olympus will quickly pay for itself in convenience and in actual time savings. If not, then return your unit for a prompt and courteous refund. If you decide to keep the SD you will positively own the best personal recorder sold today at any price. Then you can order any of the additional accessories available with the system from our inventory. Remember, there is no obligation, no postage and handling and you take absolutely no risk.

To order your unit and VA switch send $269.90 (Illinois residents add 5% sales tax) to the address shown below or credit card buyers call our toll-free number below. By return mail we will send you your Olympus SD, VA switch and one year limited warranty. Or you may order any of the other items listed below.

The Olympus SD with its VA switch represents a major new innovation in personal recording—the voice-activated recorder. Order one at no obligation today.

Olympus SD with one tape $239.95
VA switch alone 29.95
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Talk to our Computer... and it will talk back!

(Plainly speaking, it's only from the Digital Group.)

Now, your Digital Group computer becomes more than a silent partner. You can vocally command your computer . . . it will listen . . . and it will talk back to you. How? With the introduction of the exciting new Digital Group/Votrax Voice Synthesizer.

All this is possible because the Digital Group/Votrax Voice Synthesizer has an unlimited vocabulary, with 64 "human sounds" that can be combined and re-combined to form words and languages. Imagine your own computer glibly spouting [illegible], Latin, Spanish, Russian, Japanese and [illegible] average English words require [illegible] memory!

Programming the Di[illegible] Group/Vot[illegible]

The Digital Group/[illegible] Voice Synthesizer [illegible] supplied with demonstration and diag[illegible] software which will permit preliminary [illegible] Assembler listings of [illegible] code involved [illegible] included.

We have additional software available at nomin[illegible] cost:

- "Talking Basic" — $10. MAXI-Basic output converted to English.
- "Talking CW" — $10. For impressing your HAM buddies. Requires the forthcoming HAM interface card.
- "Latin and Spanish Talking" — $10. Hear the computer repeat letters and words typed in Latin or Spanish.
- Demonstration Tape — $5. A sample of audio tape and a complete explanation of the system.

Bonus: A basic input circuit is included that may be programmed to understand a small vocabulary of voice commands.

Unlimited Applications

Consider these possibilities:

- An aid for the blind, with the Voice Synthesizer supplementing a CRT display
- Astronomy — voice input and output of celestial coordinates where light would spoil "night vision"
- Robotics
- Games
- [illegible]dent terminals
- HAM radio repeater telemetry systems
- Student language pronunciation learning

[illegible] Talk Price

Actually, we should be shouting this one. The Digital Group/Votrax Voice Synthesizer, with all its capabilities, is only $495 kit or $595 assembled and tested. That's language anybody can understand.

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the digital group

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DECEMBER 1977

VOLUME 12, NUMBER 6

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- Optonica RT-3535 Cassette Deck
- dbx 128 Dynamic Range Enhancer
- E. F. Johnson 4360 CB AM Mobile Transceiver
- Sencore DVM 37 Digital Multimeter

Cover Art by Frank Bolle

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Editorial

ELECTRONICS 1978

As in recent years, 1978 should bear new electronics fruit for electronics enthusiasts. Here are some educated guesses of what is expected to bloom next year, as well as some seeds that will be planted. Of course, much depends on which way the wind blows—the traditional "out" for weather forecasters.

Video. *Video tape recorders, which flopped in the consumer market some 12 years ago, promise to gain a strong toehold in 1978. Sony's 1977 "Betamax" sales proved that the public is ripe for VTR's. Now, with many new manufacturers entering this field, combined with a four-hour video tape cartridge and the price down to $1000, sales should really gain momentum. *The video disk, which, in 1976, appeared to be a certainty for 1977, simply didn't make it. It may not in '78, either, because there is a lack of software. *Look for moderately priced microwave TV equipment for the electronics hobbyist to open up a whole new world of viewing and listening.

Communications. *In the CB radio field, expect the U.S. Coast Guard to change its view on not monitoring CB radio communications. It always struck me as a rather arrogant stance anyway, given the great number of boaters who utilize this form of low-cost radio communications. *There are many potential changes brewing in communications, but they have to wait until the conclusion of the World Administrative Radio Conference in 1979. Future possibilities include reservation of 21 new channels to ensure growth of AM radio.

Audio. *The number of direct-to-disc recordings will likely increase as more and more audio enthusiasts return to their roots and seek better sound quality. Eliminating the multi-track tape recorder from the recording process can produce a disc with superior sonic qualities. Try "Direct From Cleveland" by Lorin Maazel/The Cleveland Orchestra and "Big Band Jazz," direct-discs distributed by Discwasher and Audio Technica, respectively, as examples of how this process can show off your hi-fi system to good advantage. It's unlikely that direct-cut discs will be *big* business in the sense that conventionally produced LP's are today owing to some drawbacks: $12 to $16 price, musicians' errors cannot be edited, special effects cannot be created by remixing. But, I believe that there are enough people out there who will pay a premium price for the superior raw audio quality of non-gimmicked recordings. *I don't expect 1978 to be the year for pulse-code-modulation tape recorders to enter the consumer hi-fi component marketplace, but there will certainly be increased research toward this end. Interestingly, Mitsubishi has introduced a professional PCM tape machine which is said to have no crosstalk and no wow and flutter. There is, however, a PCM tape machine available for an audio application with a novel twist—Superscope's PIANOCORDER™. As a modern successor to the old piano roll, it adds recording capability and can be installed on any conventional piano. The tape play/record system with relays to actuate piano keys, provides a truly live performance, capturing the nuances of the actual pianist. I tried it; it works. (But on replay of my performance, I now know why they laugh when I sit down at the piano.) With pre-recorded digitalized tapes of "masters" to be available, here's a chance for piano owners to have "live" mini-concerts in their homes.

Computers. As the number of experienced users of home computer systems increases, the desirability of owning a floppy disk machine will grow. Sales of this data-storage machine, whether full-size or minifloppy, should really blossom in '78.

Miscellaneous. There are a host of other trends that should come to fruition in 1978, such as a skyrocketing growth of programmable video games and non-video electronic games; enhanced sound of music in automobiles; more and more color TV receivers with automatic control functions and electronic tuning; microprocessors in automobiles for uses such as the "miles-to-empty" digital display in Lincoln's Mark V, electronics for fuel and spark control, etc.

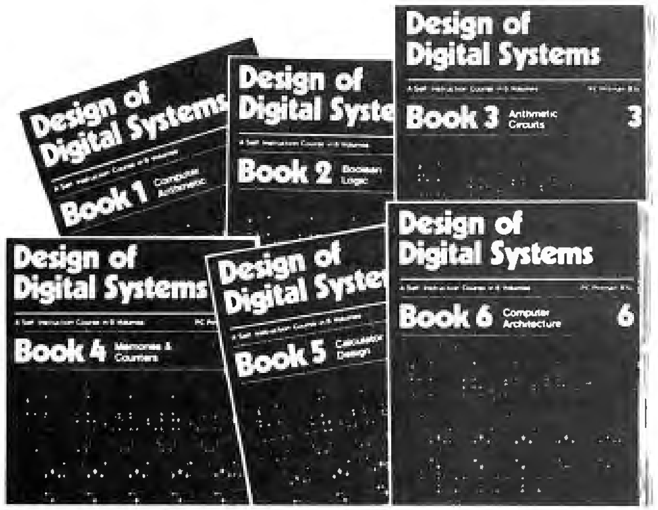
Clearly, we will all be the beneficiaries of new advances in electronics in the coming year, for convenience and for sheer fun.

Art Salsberg

Best Wishes for a Joyous Holiday Season

Understanding Digital Electronics

New teach-yourself courses



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1 / 2" x 8-1 / 4" are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input / output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1 / 2" x 8-1 / 4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your automobile speed and gas consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.

The six volumes of Design of Digital Systems cost only: **$19.88**

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Letters

USE THE OLD APPROXIMATIONS

I am sure you provided a service for many readers with the discussion in "Accurate Milliammeters On a Budget" (June 1977). As an old Ham, I wonder why you did not give the old approximations for shunt calculations and for determining the internal resistance of a meter movement. They yield results whose scalar accuracy is better than that of the meters themselves.—*D. Conover, WA6MVZ, La Mesa, CA.*

The ones presented are more accurate, though both provide results more accurate than meters themselves.

SHORTWAVE-LISTENING BOOSTER

Your articles on shortwave listening and reports on SW receivers are excellent. I am just getting started as an SWL'er, and POPULAR ELECTRONICS is helping me a great deal in my new hobby. Please keep Harry L. Helms's articles, the DX Listening column, and Shortwave Broadcasts Charts coming. —*Paul Semenza, Tarrytown, NY.*

TRANSPOSING BITS

In the "Pixie Graphics Display" article (July 1977), if the data pins on the 1861 IC are transposed, the bits will be displayed with the LSB first and the MSB last. This arrangement will be a little easier to use when calculating a display from software or an A/D converter. Just transpose D7 and DØ, D6 and D1, D5 and D2, and D4 and D3.—*Richard DeLombard, Huron, OH.*

TVT-6 DISPLAY UNCROWDING

We built a "TVT-6 Video Display" unit (July 1977) and interfaced it with a KIM microcomputer. While following your published debugging instructions, we noted that our video monitor was displaying letters that were not complete because they were crowded together. Signal tracing revealed that the LOAD signal was okay but the CLOCK signal presented only 3 cycles/µs instead of the specified 6 cycles/µs. I tried replacing *C5* with a smaller value of capacitance, with the result that the display was greatly improved. After some cut-and-try experimenting, we ended up with a 390-pF value and a perfect display. Anyone who runs into a similar problem with one of these video-display units might want to take note of our experience. —*David A. Byrd, Memphis, TN.*

ENLARGER REGULATOR PRECAUTION

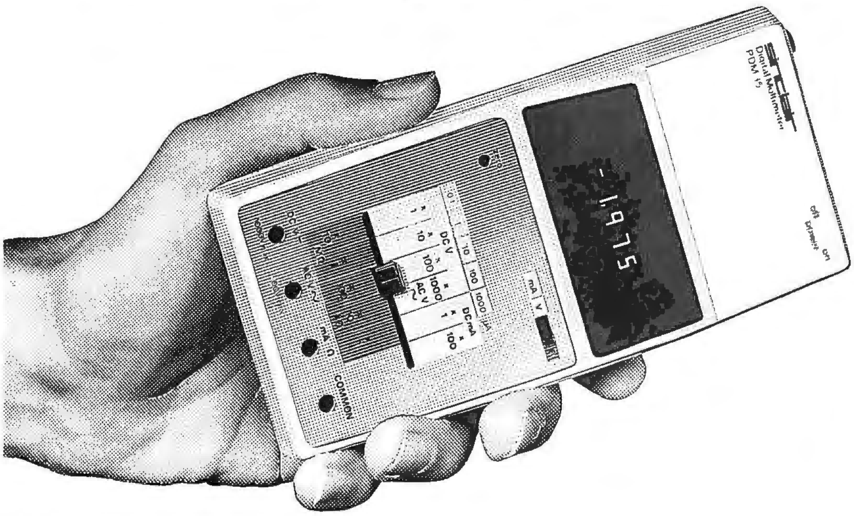
Since your enlarger voltage-regulator project in the November 1977 issue is specifically aimed at the *color* darkroom worker, it would be well to point out that this regulator cannot be used with some enlarger color heads that have built-in filtration. Such heads usually have low-voltage, high-intensity lamps and transformer power supplies. Use of a dc supply, like that shown for the regulator in the November issue, can result in damage to the transformer. —*Bennett Evans, New York, NY.*

Out of Tune

In "How to Convert a 'Four Banger' for Stopwatch Functions" (August 1977), the *IC2* and *IC3* designations are shown transposed in Fig. 2. The Fig. 1 schematic diagram is correct.

In the Parts List in "Build a Digital Camera Shutter Timer" (August 1977), *DIS1* through *DIS5* are described as common-anode displays; they are actually common-cathode displays.

The Sinclair PDM35.
A personal digital multimeter for only $49·95



Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter – quick clear readings, high accuracy and resolution, high input impedence. Yet at $49.95 it costs less than you'd expect to pay for an analog meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ±1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 µA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adapter.
Industry standard 10 MΩ input impedance.

Compare it with an analog meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analog meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comarable analog meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analog meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adapter.
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Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

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I enclose check/MO order made out to Sinclair Radionics Inc (indicate total order value. Add 4% sales tax for NYS deliveries): ...... $______
I understand that if I am not completely satisfied with my PDM35, I may return it within ten days for a full cash refund.

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New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

H-P PRINTING CALCULATOR

Hewlett-Packard's new HP-19C is the first pocket-sized programmable calculator with a built-in printer. The model is key-stroke programmable, with 98 fully-merged program steps, continuous memory, full editing and

programming functions, 30 data-storage registers, and a thermal printer, as well as an LED display. Programming features include 10 addressable labels, indirect addressing, and three subroutine levels, as well as back-step, insert/delete, single-step, pause, and a total of 10 decision tests. The printer may be set to print out the calculations, to list the program, or to print only when called for by a key or a list function. For further information, write Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Road, Palo Alto, CA 94304.

HEATHKIT DIGITAL BATHROOM SCALE

Heath's Model GD-1186 "Digit-Scale" reads from 0 to 300 lb, in increments of 0.2 lb, on a detachable LED digital display. The scale uses a strain-gauge transducer rather than conventional springs, weights or pins. It can also be zeroed for weighing small items, and extra cable is supplied to allow the read-out to be mounted at eye level or on any handy surface. Power is from six "C" cells (not included). Kit price, $99.95; assembled, $139.95

CIRCLE NO 90 ON FREE INFORMATION CARD

COLT CB AM TRANSCEIVER

An exceptionally small, 40-channel Citizens Band mobile transceiver, measuring only 4.5" wide by 1.4" high has been announced by Colt Communications. The Model 350 fea-

tures a LED digital channel display, volume, squelch, transmit lamp, variable-intensity LED indicators for signal strength and r-f output, and automatic noise limiting and noise blanking. $199.95

CIRCLE NO 87 ON FREE INFORMATION CARD

FISHER AM/STEREO FM RECEIVER

At the top of the new Fisher receiver line is the Studio Standard RS1080, an AM/stereo FM receiver with a continuous power output rating of 170 watts per channel into 8 ohms, with no more than 0.08% THD. Other specifications are: less than 0.03% THD at normal listening levels and IHF usable FM sensitivity, 1.6 microvolts (9.3 dBf). In addition to Baxandall treble and bass tone controls, a "tuned bass extender" can boost bass at either 45 or 80 Hz. There's also a tone-control defeat switch and high and low filter switches. The

volume control has 21 calibrated dB steps. Other features include an FM front end with 5-gang tuning, PLL multiplex decoder, FM Dolby switch, front-panel tape jacks, and three meters for channel center, signal strength and multipath. $999.95.

CIRCLE NO od ON FREE INFORMATION CARD

CSC DIGITAL PULSER PROBE

The Continental Specialities Corp. Model DP–1 digital pulser can moniter the circuit node under test and then preset its dual output circuitry to pulse the node in the reverse polarity. The probe delivers a 50-mA pulse in the CMOS mode or 100-mA pulse in the TTL mode, sufficient to toggle most lines without requiring isolation of the circuit being tested. Power for the probe is obtained from the circuit under test to assure logic-level compatibility. A switch is provided for selecting the appropriate thresholds to trigger either TTL or CMOS circuits. The PULSE button can be mo-

mentarily pressed to deliver a single pulse, or it can be held down to deliver a train of pulses. A LED blinks once to indicate a single pulse and remains on to indicate a train of pulses. Probe tips are interchangeable with optional tips and accessories. $74.95.

CIRCLE NO 89 ON FREE INFORMATION CARD

TECHNICS DIRECT-DRIVE TURNTABLE

Technics by Panasonic introduces its new Model SL-2000 direct-drive turntable. Among its features are an IC-controlled servo motor, computer-analyzed tonearm, direct-reading antiskating device, an illuminated stroboscope, and independent pitch controls for 33⅓ and 45 rpm. The tonearm base is die-

cast zinc, and Insulation Fiber Board is included to help control feedback. Audio isolation in the turntable feet is also used toward this end. Wow and flutter are rated at 0.045% wrms and rumble at -70 dB DIN B. Pitch controls can vary the motor speed by 10%.

CIRCLE NO 91 ON FREE INFORMATION CARD

CB POWER PACK/TRANSCEIVER CASE

Kendon Manufacturing Co.'s CB Power-Mate is a combination transceiver carrying case and power pack. It is made of high-impact ABS plastic and accommodates nine zinc-carbon, alkaline, or NiCd C cells. A built-in meter indicates battery condition. The CB Power-Mate includes a 63-inch (1.6-m) whip antenna tuned to 27 MHz, a carrying strap,

What you should expect from a $700 DC amp and matching tuner. Waveform fidelity.

Introducing the 8080 Series, Technics integrated DC amp and matching tuner. Two remarkable components with waveform fidelity: The ability to reproduce sound waves. Square waves. Even tone burst signals. It's the only kind of performance you should expect from an integrated amp and tuner. Especially for $700.*

To create an amp that would accurately amplify waveforms, we took some unusual steps with the SU-8080. Like eliminating all coupling capacitors and thereby eliminating a major source of phase shift, noise and distortion. Another step toward waveform fidelity is a frequency response of DC~100 kHz —1 dB.

And to complement our unconventional DC integrated amp, we added an extremely quiet phono equalizer complete with Technics own ultra-low-noise transistors. The result: An increased phono S/N ratio of 100 dB at 10 mV with sharply reduced circuit and transistor noise especially when compared to conventional amps. We also added some unconventional controls. Like a subsonic filter in the phono equalizer and a four-step phono impedance selector.

Equally impressive is the performance of our ST-8080 tuner. To boost sensitivity while greatly reducing interference signal levels, there are two RF stages with low-noise, 4-pole, dual-gate junction FETs as well as a linear FM variable tuning capacitor. At the same time, Technics-developed flat group delay filters increase selectivity without increasing distortion.

There's also a new Phase Locked Loop IC in the MPX circuit as well as a pilot signal canceler for razor-sharp cancellation of the 19 kHz pilot signal and ruler-flat high-end response: 20Hz to 18 kHz (+0.2 dB, —0.8 dB).

Now that you know what waveform fidelity means in a DC amp and tuner, take a look at what waveform fidelity means in their specs.

SU-8080 Amp. POWER OUTPUT: 72 watts per channel min. RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% total harmonic distortion. S/N (IHF A): 115 dB. PHONO S/N (IHF A): 100 dB (10 mV).

ST-8080 Tuner. 50 dB QUIETING SENSITIVITY: Mono 13.6 dBF. Stereo 34.3 dBF. SELECTIVITY: 85 dB. THD: Mono 0.15%. Stereo 0.3%. CAPTURE RATIO: 1.0 dB.

Technics 8080 Series. A rare combination of audio technology. A new standard of audio excellence.

*Technics recommended prices: SU-8080 is $449.95 and ST-8080 is $249.95, but actual retail prices will be set by dealers.

Technics Professional Series
by Panasonic

CIRCLE NO. 63 ON FREE INFORMATION CARD

and universal hardware that allows fast hookup to most 23- or 40-channel mobile transceivers.

CIRCLE NO. 92 ON FREE INFORMATION CARD

LEAK SPEAKER SYSTEM

Rank Hi-Fi has introduced the Leak 3050, a time-delay-compensated, two-way speaker system with acoustic-suspension woofer. The system crosses over above 4 kHz to a ¾" (19 mm) dome tweeter with response to 22 kHz (−3 dB). The bass is handled by two, 6.7" (170 mm) drivers in a well-damped air-suspension cabinet, with response down 3 dB at 48 Hz. The tweeter is mounted a precisely calculated distance behind the plane of the woofer panel, so that its harmonics will arrive at the ear in step with the fundamental frequencies from the woofer/midrange drivers. Nominal impedance is 8 ohms, and sensitivity is rated at 85 dB SPL at 1 meter for a 1-watt input. Recommended amplifier power is between 12 and 60 watts/channel, rms; power handling is rated at 50 watts by DIN standards. The system measures 25¼"H x 11¾"W x 13¾"D (64 x 30 x 35 cm) and weighs 42 lb (19 kg).

CIRCLE NO. 93 ON FREE INFORMATION CARD

SENCORE NONCONTACT SIGNAL PROBE

A closed-loop signal pickup probe for frequency counters is available from Sencore. The "Snoop Loop," which requires no direct connection to the signal source being measured, connects directly to a 50-ohm input cable. It can be used to "snoop back" along the *signal* path into low-level circuit areas, and can even be placed directly over oscillator coils without upsetting the oscillator's operating frequency, according to the manufacturer. $9.95

CIRCLE NO. 94 ON FREE INFORMATION CARD

HALLICRAFTERS 2-METER TRANSCEIVER

The Hallicrafters H2M-1000 is a two-meter amateur transceiver with PLL frequency synthesis that operates in FM, USB, LSB, and CW modes. In the FM mode, it provides 800-channel coverage in 5-kHz steps with VXO variation of ±7 in SSB/CW. Other features include a simplex mode, repeater offsets of

(Continued on page 14)

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Introducing Apple II.™

The home computer that's ready to work, play and grow with you.

Clear the kitchen table. Bring in the color T.V. Plug in your new Apple II,* and connect any standard cassette recorder/player. Now you're ready for an evening of discovery in the new world of personal computers.

Only Apple II makes it that easy. It's a complete, ready to use computer—not a kit. At $1298, it includes features you won't find on other personal computers costing twice as much.

Features such as video graphics in 15 colors. And a built-in memory capacity of 8K bytes ROM and 4K bytes RAM—with room for lots more. But you don't even need to know a RAM from a ROM to use and enjoy Apple II. It's the first personal computer with a fast version of BASIC—the English-like programming language—permanently built in. That means you can begin running your Apple II the first evening, entering your own instructions and watching them work, even if you've had no previous computer experience.

The familiar typewriter-style keyboard makes communication easy. And your programs and data can be stored on (and retrieved from) audio cassettes, using the built-in cassette interface, so you can swap with other Apple II users. This and other peripherals—optional equipment on most personal computers, at hundreds of dollars extra cost—are *built into* Apple II. And it's designed to keep up with changing technology, to expand easily whenever you need it to.

As an educational tool, Apple II is a sound investment. You can program it to tutor your children in most any subject, such as spelling, history or math. But the biggest benefit—no matter *how* you use Apple II—is that you and your family increase your familiarity with the computer itself. The more you experiment with it, the more you discover about its potential.

Start by playing PONG. Then invent your own games using the input keyboard, game paddles and built-in speaker. As you experiment you'll acquire new programming skills which will open up new ways to use your Apple II. You'll learn to "paint" dazzling color displays using the unique color graphics commands in Apple BASIC, and write programs to create beautiful kaleidoscopic designs. As you master Apple BASIC, you'll be able to organize, index and store data on household finances, income tax, recipes, and record collections. You can learn to chart your biorhythms, balance your checking account, even control your home environment. Apple II will go as far as your imagination can take it.

Best of all, Apple II is designed to grow with you. As your skill and experience with computing increase, you may want to add new Apple peripherals. For example, a refined, more sophisticated BASIC language is being developed for advanced scientific and mathematical applications. And in addition to the built-in audio, video and game interfaces, there's room for eight plug-in options such as a prototyping board for experimenting with interfaces to other equipment; a serial board for connecting teletype, printer and other terminals; a parallel interface for communicating with a printer or another computer; an EPROM board for storing programs permanently; and a modem board communications interface. A floppy disk interface with software and complete operating systems will be available at the end of 1977. And there are many more options to come, because Apple II was designed from the beginning to accommodate increased power and capability as your requirements change.

If you'd like to see for yourself how easy it is to use and enjoy Apple II, visit your local dealer for a demonstration and a copy of our detailed brochure. Or write Apple Computer Inc., 20863 Stevens Creek Blvd., Cupertino, California 95014.

Apple II™ is a completely self-contained computer system with BASIC in ROM, color graphics, ASCII keyboard, lightweight, efficient switching power supply and molded case. It is supplied with BASIC in ROM, up to 48K bytes of RAM, and with cassette tape, video and game I/O interfaces built-in. Also included are two game paddles and a demonstration cassette.

SPECIFICATIONS

- **Microprocessor:** 6502 (1 MHz).
- **Video Display:** Memory mapped, 5 modes—all Software-selectable:
  - Text—40 characters/line, 24 lines upper case.
  - Color graphics—40h x 48v, 15 colors
  - High-resolution graphics—280h x 192v; black, white, violet, green (16K RAM minimum required)
  - Both graphics modes can be selected to include 4 lines of text at the bottom of the display area.
  - Completely transparent memory access. All color generation done digitally.
- **Memory:** up to 48K bytes on-board RAM (4K supplied)
  - Uses either 4K or new 16K dynamic memory chips
  - Up to 12K ROM (8K supplied)
- **Software**
  - Fast extended Integer BASIC in ROM with color graphics commands
  - Extensive monitor in ROM
- **I/O**
  - 1500 bps cassette interface
  - 8-slot motherboard
  - Apple game I/O connector
  - ASCII keyboard port
  - Speaker
  - Composite video output

Apple II is also available in board-only form for the do-it-yourself hobbyist. Has all of the features of the Apple II system, but does not include case, keyboard, power supply or game paddles. $798.

PONG is a trademark of Atari Inc.

*Apple II plugs into any standard TV using an inexpensive modulator (not supplied).

CIRCLE NO. 78 ON FREE INFORMATION CARD

apple computer inc.™

NEW PRODUCTS

(Continued from page 10)

±600 kHz and ±1 MHz, LED frequency display (six digits in FM mode, five digits in SSB), S/r-f and discriminator meters, standard and slow agc, built-in VOX, receiver-incremental tuning, noise blanker, mike gain

control, and ac or dc operation. R-f power output exceeds 10 watts in high-power mode, and is one watt in low-power mode.

CIRCLE NO. 95 ON FREE INFORMATION CARD

SOUNDCRAFTSMEN POWER AMPLIFIER

The Soundcraftsmen MA5002 power amplifier is said to deliver 250 watts per channel into 8 ohms at less than 0.1% THD, using a new type of circuit—class "H." According to Soundcraftsmen, its "variproportional" circuit anticipates power demands and supplies only the amount of power required by the input signal voltage. It's claimed that this reduces the dissipation of energy as heat loss and increases efficiency. The "new Class" amplifier requires about 40% less input pow-

er at the one-third-power point used in FTC power amplifier tests and needs no cooling fan. The amplifier also features overload circuits with automatic reset, LED clipping indicators, VU meters with three ranges, and switching for two pairs of speaker systems.

CIRCLE NO 96 ON FREE INFORMATION CARD

OLYMPUS MICROCASSETTE RECORDER

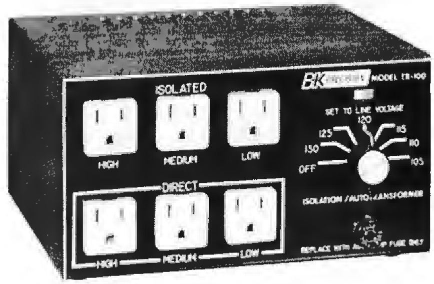
Olympus introduces the Pearlcorder SD, a second-generation pocket-size microcassette recorder with capstan drive. It uses Olympus' 60-minute microcassettes. Operating life from two AA alkaline cells is claimed to be 11 hours of continuous recording time. Its control line-up includes cue, rewind, fast forward, and pause. A coreless motor maximizes speed constancy. A ferrite head is claimed to provide a record/playback frequency range of 300 to 7000 Hz. The recorder is designed to accept a number of accessories, including an external amplifier/speaker, AM and FM tuner modules, voice actua-

tor, tie-clip microphone, and remote adaptor. $240 for the basic recorder; $260 for Standard SD combination.

CIRCLE NO 97 ON FREE INFORMATION CARD

B&K-PRECISION AUTOTRANSFORMER

B&K-Precision announces its Model TR-100 combination isolation/autotransformer for bench use. Three isolated and three direct outlets are available simultaneously, providing high, medium, and low (130, 115, and 105 volts ac) line voltages. The isolated outlets



are rated at 400 VA continuous, while the direct outlets are rated at 500 VA. The TR-100 allows safe testing of transformerless equipment, eliminating a potential shock hazard, and can be used to vary the line voltage applied to an electrical device or instrument under test. The adjustment range is from 105 to 130 volts ac. $55.

CIRCLE NO 98 ON FREE INFORMATION CARD

ANTLER CB BASE ANTENNA

The new Antler Antennas Model B-12 is an omnidirectional gain antenna designed for CB use on 40 channels. It is said to have an extremely low SWR, claimed by the manufacturer to be less than 1.1:1.0. The antenna has an 8'4" (2.5-m) maximum radiator above a three-element drooping ground plane and a 6'3" (2.2-m) turning radius. It is rated at 50 ohms and is vertically polarized. A vhf connector is provided to mate with the standard PL-259 coaxial fitting found on most CB transceivers. The antenna is made of heavy-walled, step-tapered seamless aluminum tubing and a reinforced base mast to bear up to high wind-loading conditions. $36.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

New Literature

WESTINGHOUSE TECH TIPS

"A Graphical Approach to Paralleling Semiconductors" is the title of Tech Tips 5-6 from Westinghouse. The 7-page article explains how to determine how many semiconductors must be used in parallel for high-current systems. It discusses, step-by-step, a graphic technique that quickly establishes the number of required devices of a given rating. A set of curves and a specific example show the technique in actual application. Address: Semiconductor Div., Westinghouse Electric Corp., Youngwood, PA 15697.

GC CB ACCESSORIES CATALOG

GC Electronics has issued a 24-page catalog describing its line of CB accessories. Products listed include microphones, connectors, audio system accessories, antennas and exact replacement parts, auto alarms, mounts, cables, interference suppressors, maintenance items, and performance indicators. Items are illustrated and specification information provided. Address: GC Electronics, 400 South Wyman, Rockford, IL 61101.

KESTER SOLDERING CATALOG

Kester Solder, a division of Litton Industries, offers a 12-page catalog on its line of solder and soldering accessories. Products described include standard solders, flux core solders, soldering fluxes, vapor degreasing solvents and chemicals. An introductory section discusses the basics of solder and soldering methods. A temperature chart and application guide are also provided. Address: Kester Solder, 4201 Wrightwood Ave., Chicago, IL 60639.

CB RADIO IC BROCHURE

"Personal Communications: CB Radio," National Semiconductor's new 11-page booklet, describes the integrated circuits and electronic components designed for use in the manufacture of citizens band radios. Products described include synthesizer systems, 5-pin audio amplifiers, microprocessor-controlled tuning systems, linear IC's, LED's, clock modules, r-f output discretes and regulators. Text is supplemented with line drawings, block diagrams and photos. Address: National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051.

CELESTION SPEAKER LINE CATALOG

Celestion Industries, Inc., has prepared a comprehensive short-form catalog that details all six speaker systems in its line. In addition to detailed specifications on each model, the six-page folder discusses the company's overall design philosophy. All of the speaker systems are pictured, and each of the drivers is graphically illustrated. A specifications chart lists all the major parameters of each model. Address: Celestion Industries, Kuniholm Dr., Holliston, MA 01746.

EIA CONSUMER GUIDE TO TV SAFETY

A revised "Consumer Guide to Television Safety" has been published by the Electronic Industries Association/Consumer Electronics Group. The Guide offers a number of basic steps to be followed by consumers for safe and efficient operation of TV receivers. Send self-addressed, stamped envelope to: Sally Browne, Director of Consumer Affairs, EIA/ Consumer Electronics Group, P.O. Box 19369, Washington, DC 20036.

CORRECTION

In the September "New Literature," "Analog Switch Handbooks" were listed as publications of Siltronix Inc. The company should have been Siliconix Incorporated. The address was correct.

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NRI offers you five TV/Audio Servicing Courses

NRI can train you at home to service Color TV equipment and audio systems. You can choose from 5 courses, starting with a 48-lesson basic course, up to a Master Color TV/Audio Course, complete with designed-for-learning 25" diagonal solid state color TV and a 4-speaker SQ™ Quadraphonic Audio System. NRI gives you both TV and Audio servicing for hundreds of dollars less than the two courses as offered by another home study school.

All courses are available with low down payment and convenient monthly payments. All courses provide professional tools and "Power-On" equipment along with NRI kits engineered for training. With the Master Course, for instance, you build your own 5" wide-band triggered sweep solid state oscilloscope, digital color TV pattern generator, CMOS digital frequency counter, and NRI electronics Discovery Lab.

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NRI's Complete Communications Course includes your own 400-channel VHF transceiver

NRI's Complete Communications Course will train you at home for one of the thousands of service and maintenance jobs opening in CB; AM and FM transmission and reception; TV broadcasting; microwave, teletype, radar, mobile, aircraft, and marine electronics. The complete program includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own "designed-for-learning" 400-channel VHF transceiver; electronics Discovery Lab™; CMOS digital frequency counter; and more. You also get your all important FCC Radio-telephone License, or you get your money back.

CB Specialist Course also available

NRI also offers a 37-lesson course in CB Servicing with your own CB Transceiver, AC power supply, and multimeter. Also included are 8 reference texts and 14 coaching units to make it easy to get your Commercial Radiotelephone FCC License.

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Stereo Scene

By Ralph Hodges

THE MYSTERIOUS WEST

WHEN it comes to cassettes, or even to magnetic tape in general, the Far East has been much less mysterious than the Far West—western Europe, in other words. One doesn't hear much from the Common Market countries about what we in the U.S. and elsewhere are doing with the cassette, which was after all conceived and developed in the Netherlands. And we are in fact doing a great deal with it: Dolbyizing it, chromium-dioxiding it, and generally trying to turn it into a super-audiophile medium, which is not what its originators had in mind.

On a recent visit to BASF in southwest Germany, a touring group of press people, of which I was one, got a first-hand look—albeit a very brief one—at the environment into which the cassette was born and nurtured through infancy. We, or at least I, encountered a few surprises. I had been led to expect a market dominated much more than is the case here by "compact" music systems and carry-around portable machines. The surprise was in seeing the inclusion of refinements one would not normally anticipate on a widespread basis in such mundane hardware. Dolby B-type noise reduction and chromium-dioxide bias and equalization are common in this seemingly modest equipment. In fact, the Germans are quite high on chrome and the Dolby system, despite their origins abroad, and many tape and equipment manufacturers assume its use in specifying product performance, just as here.

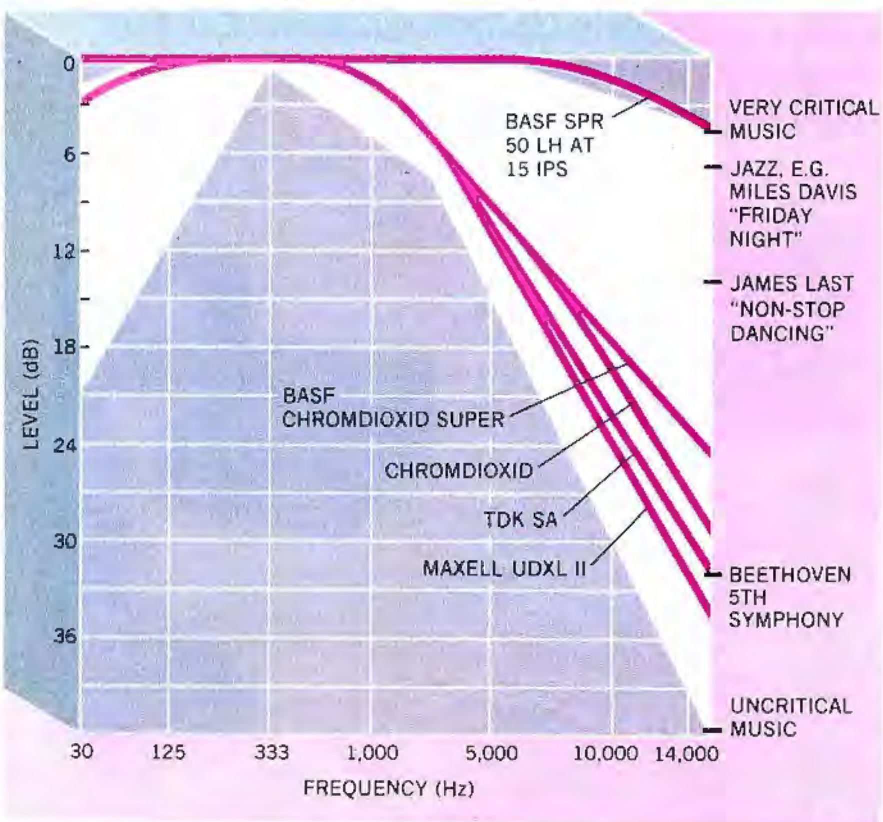
BASF has enormous research and manufacturing resources in Europe, and its present small share of the U.S. market does not really represent its true strength. So it was with interest that we explored what products and philosophies are being readied by BASF to convert the U.S. consumer to a pro-Europe outlook in general (and a pro-BASF view in particular).

Chromium Dioxide. BASF intends to stick with chromium-dioxide tape through thick and thin, and to combat the claims made for the "chrome-substitute" tapes (Maxell UDXL II and TDK SA being the most prominent) as vigorously as possible. Figure 1 presents some of the data on which the company bases its decision. It seems that German radio broadcasters have cooperated over the years in compiling statistical data on the dynamic range of recorded (presumably on disc) program material. In Fig. 1, BASF has plotted these dynamic-range requirements according to frequency, and overlaid the plot with the dynamic-range capabilities of various tapes. The crosshatched area represents the requirements for uncritical music, while indicated points on the right hand vertical scale show the very-high-frequency demands of certain special cases. All the tapes have been biased at their theoretically optimum points, and their maximum output levels (MOL's) at 333 Hz, referred to the 3 percent distortion point, have been arbitrarily set at 0 dB.

The first thing to note is that the BASF professional open-reel tape, operating at 15 ips, almost exactly "fits" the requirements of "very critical music" from the lowest to the highest frequencies indicated, whereas all the cassette samples fall far short at the highest frequencies. However, they encounter no apparent difficulties at middle and low frequencies, where they are approximately equal. The best of the high-frequency performers, BASF's brand new Chromdioxid Super, reflects the company's view that the extreme high frequencies are where cassette improvements should be happening—an opinion that no one who has done much cassette recording is likely to dispute.

One thing that does *not* show up in these data is chromium dioxide's much talked-about MOL limitations at middle and low frequencies. When queried about this, the BASF people responded that MOL for these frequencies is really only a function of oxide-coating thickness—a statement that is quite in line with current tape-recording theory. However, what then is to be made of all the reported measurements showing chromium dioxide as several dB deficient in

Fig. 1. How dynamic ranges of various tapes "fit" dynamic-range requirements of different types of music according to BASF's data.



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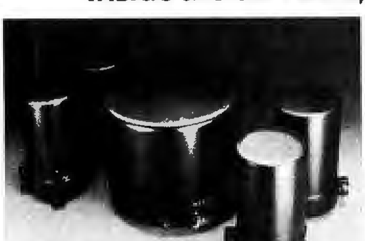
WHEN YOU'RE NOT IN A RUSH TO CATCH UP, YOU'VE GOT THE TIME TO BUILD THINGS RIGHT.

When Pioneer first introduced the 160 watt* SX 1250 last year, it prompted our competitors to hastily introduce a bevy of high powered receivers.

Unlike the others, however, the SX 1250 wasn't a rush job. And the time and care that went into it can both be seen and heard.

Inside the SX 1250, for example, you'll find that we took the time to shield every critical section. So spurious signals from one section can't leak into another. And dirt and dust can't get in to affect performance. So the SX 1250 not only produces crisp, interference-free sound when it's new, but still sounds great as it grows old.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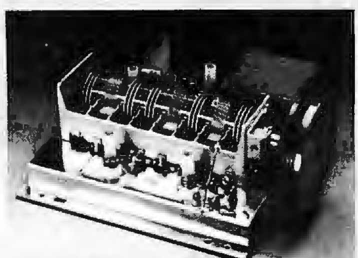
And where most high powered receivers come with a three, or four gang variable capacitor for FM tuning, the SX 1250 features a *five* gang zinc plated variable capacitor that cleans up FM reception much better. And helps to pull in stations that some three or four gang capacitors can't even touch.


A five gang variable capacitor for FM reception that never varies.

Obviously, these are only a few of the refinements that went into the SX 1250. But given just these few things, it should come as no surprise that the SX 1250 even weighs more than most of our competitors' high powered offerings.

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CIRCLE NO. 65 ON FREE INFORMATION CARD

long-wavelength MOL? Underbiasing of the tape machine would offer an explanation, but BASF has other data indicating that most cassette decks are quite close to optimum bias for CrO_2. I guess we'll have to await clarification on this.

Head Wear. Another damning charge that has been levelled against CrO_2 is its purported tendency to accelerate tape-head wear. BASF most vigorously disputes that accusation, and Fig. 2 graphs their test results for BASF chrome versus one of the leading chromium-dioxide "substitutes" employing an alloy head made of Philips' Recovac material.

The results indicate that the substitute is actually somewhat more abrasive under the test conditions used, but the company spokesman hastened to assure us that neither tape wears heads at a rate that could be considered significant, and that a cassette deck's head could be expected to outlast its mechanicals in almost every case. Furthermore, he stated that the oxide material itself is not the overwhelming factor in head wear. The binder system, surface polish, and the proper orientation of the needle-shaped oxide particles play a major role as well.

To me, all of this sounds very plausible. But, again, it does not exactly square with reports I have heard from one or two major cassette-machine manufacturers (and proponents of chromium dioxide) to the effect that head wear *is* a factor in machines returned for servicing—one that has encouraged periodic investigations into new head materials. This wear, I should say, was not attributed only to CrO_2, but was said to be brought on by almost any tape a consumer might use.

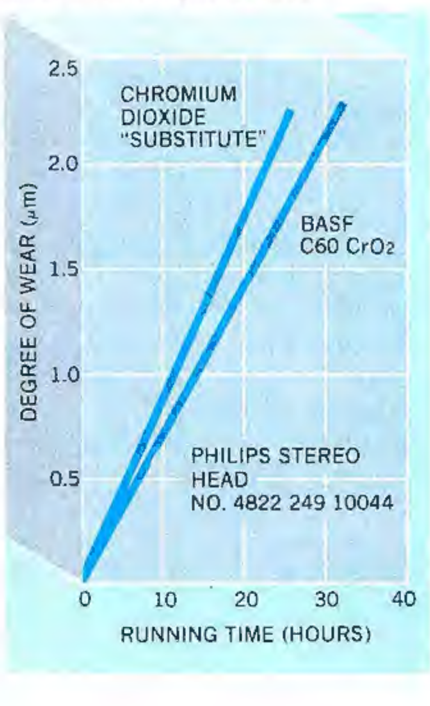
Metal tapes. In late spring of this year, 3M/Scotch announced its intention to market a cassette tape employing a pure metal magnetic particle (as compared to the traditional metal-oxide one). This did not come as a complete surprise; research into pure metal tapes on the part of several tape manufacturers has been an open secret for years. The big question has been which manufacturer will be first. According to BASF, the introductions from the leaders (principally 3M, TDK, Philips, and BASF) will occur almost simultaneously. But it appears that all metal tapes will not be the same.

Metal tapes have the potential for vastly increased MOL's at all audio frequencies. An improvement of 10 dB across the frequency board has been suggested as a reasonable expectation. In general, these tapes also involve a much higher coercive force than currently available products, and this will call for a greatly increased bias current in the tape heads used for recording.

It's typically the case with magnetic tape that a manufacturer has some choice as to where he will take his dynamic-range benefits. BASF says that, in the light of the data presented in Fig. 1, it will design its metal tape to concentrate on increased high frequency dynamic range, leaving the longer-wavelength capacity pretty much as it now stands with present-day tapes. But high-frequency dynamic range is foreseen, at 1 7/8 ips, to virtually equal that of the professional tape of Fig. 1 at 15 ips—a breathtaking prospect!

The heavy bias requirements of metal tape has been a worry to its developers; heads that will not saturate magnetically or even overheat under these conditions are not easy to come by. BASF's answer to this is the Sendust-alloy head introduced by JVC last year. From all reports, the Sendust head exhibits remarkable linearity over a wide dynamic range, which is exactly what is needed. But it is also said by some to be troublesomely nonlinear at very low signal levels. Possibly the metal-tape application with its high bias currents is able to get around this problem. Certainly BASF does not admit to encountering any such difficulty. Again, only time will tell.

Fig. 2. Head wear vs. running time for BASF CrO_2 cassette and ferric CrO_2 "substitute."



On to Video. Although details are still a little sketchy, BASF is reportedly testing prototype versions of a videotape camera that will be able to compete in all physical respects with current photographic motion-picture cameras, while adding the capability of "instant playback." The camera records the tape linearly (as opposed to a helical-scan system). One end of the 8-millimeter tape enclosed within the tape cartridge is withdrawn and fed into the camera's mechanism at a rate of 120 ips. When the tape ends, the mechanism reverses almost instantaneously and begins laying down a parallel recorded track in the opposite direction. This forward-reverse process continues until more than forty-eight parallel tracks have been laid down on the tape.

The potential appeal of such a system, at least in the U.S. market, is an unknown quantity.

It's obvious that videotape cannot yet compete with photographic processes in terms of picture quality. Image resolution and color values will be comparable, at best, to what you can get from your TV set with the finest program material, which can be most satisfactory of course. Nor, as yet, is there any practical way to edit a videotape such as BASF is proposing. In addition, reports from this country indicate that most videotape users within the U.S. market use their equipment almost exclusively for off-the-air recording of TV broadcasts, for which a camera is unnecessary.

If the BASF playback equipment for these videotapes is attractively priced (as seems likely), and if the company is prepared for the hard grind of warming up and selling an uninitiated consumership, success is certainly within reach. On the positive side, BASF expects its major opponent in this area to be Kodak, which is reported to be gearing up for a competing system with the help of its magnetic-products experts based in France. If Kodak is casting hungry glances at this market, and if Polaroid is beginning to become (as murmurs indicate) more than a little interested, a truly fine free-for-all could take place in very short order.

The Crystal Ball. There is, I believe, no way in which a handful of jet-lagged journalists could plumb all the mysteries of Europe and its attitudes toward and plans for the U.S. audio-video market. But they seem, as always, to be highly ambitious, although now tempered with a conservatism born of experience. ◇

Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

WHAT NEXT IN HIGH FIDELITY?

AT YEAR'S END, it is customary to make predictions of things to come. In the case of high-fidelity components, this calls for an exceptionally large, high-definition crystal ball, plus a willingness to speculate openly with little likelihood that one will be more accurate than random chance allows. I will nonetheless venture some guesses as to the direction of audio developments in the near future.

Firstly, let us identify the basic problem areas, in which genuine breakthroughs could make a significant improvement in sound quality:

(1) *Speaker Systems.* If there is anything in the controversial world of hi-fi on which almost everyone will agree, it is that the speaker system is the weakest link in the audio chain. (I say *almost* because I personally think that the recording itself, and the acoustic properties of the listening room, have as much to do with the realism of the final sound as any of the system components.)

Although the fundamental theory of the speaker system has been well-known for at least a half century, and there has been no lack of effort on the part of hundreds of talented engineers over the years, there have been remarkably few *really* new speaker developments for several decades. The "sameness" of most contemporary speaker systems, both in basic design and sound character, is perhaps their most striking feature. This is not really a bad thing, of course, since the plateau of sound quality on which the speaker industry finds itself is very high indeed, by comparison to only a few years ago.

On the other hand, no speaker system I have heard so far sounds identical to real, live music. True, in isolated cases, using specially prepared program material and with exceptional care in controlling the listening environment, it has been possible to do a remarkably accurate job of simulating a live music source. But this is very much the exception, so that you and I, in our homes, enjoy at best a pallid imitation of the "real thing," consoling ourselves with floor-shaking bass, sizzling highs, pin-point stereo directionality, and other hi-fi accoutrements that are notably lacking in much real music.

The problem, in a nutshell, is that no one really knows what a speaker system should do to produce "real" sound. There are as many theories as there are serious workers in the field, plus a goodly number of fanciful notions from less qualified people. Perhaps one of these days someone will establish beyond a reasonable doubt what properties a speaker system must have to create a convincing illusion of reality (if, indeed, that is within the capability of the speaker at all). Once that has been determined, I have no doubt that speaker systems meeting those requirements will soon be forthcoming.

(2) *Phono Cartridges.* It is not surprising that the other electromechanical transducer in a typical audio system shares top billing with the speaker system in the lineup of hi-fi miscreants. Both are given impossible tasks to perform and then proceed to do their jobs with fantastic success.

One of the keys to successful phono cartridge performance is actually outside the cartridge itself. It is in the manner in which a specially shaped diamond stylus traces the undulations in a spiral groove pressed into a vinyl disc. It is mind-boggling to consider what the stylus goes through as it follows the groove modulation, gyrating through a full 360°, at rates up to 20,000 times per second (up to 45,000 times per second on discrete four-channel discs). Simply maintaining contact with the record is no small achievement for the stylus during its wild ride. Since any loss of contact with the groove walls produces some of the most unmistakable and unpleasant distortion in all of audio, anyone who ever listens to a record must appreciate how successfully the stylus fulfills its mission.

More is required for really accurate record reproduction, however. The stylus path must accurately duplicate the motion of the cutting stylus that made the original master disc. If the playback stylus ventures off in a different direction from time to time, even though still riding on the record, the result is distortion. Sad to say, this is the normal condition in record playing. The record is cut with a chisel-edged stylus, and played with one having rounded contact surfaces. There is no way for the latter to follow the exact path of the former. A closer approximation is possible when the contact radius of the playback stylus is made very small, approaching the fine edge of the cutting stylus. This was the rationale for the development of the widely used elliptical stylus shape. The Shibata and other special stylus designs, required for playing the ultrasonic frequencies on CD-4

discrete four-channel discs, offered even more promise for accurate tracing of stereo records. They are quite expensive, but several companies have announced cartridges with modified forms of these stylus shapes that give improved stereo performance without the full cost penalty of the CD-4 shape. (The Stanton Model 881S, reviewed this month, is a typical example.)

Since many records are "predistorted" to compensate in part for the tracing limitations of a conical stylus, it may well be that an extreme elliptical shape, or a modified CD-4 stylus shape, will produce *more* playback distortion than a simple conical stylus. Nevertheless, this distortion, unlike that from mistracking, is rarely disturbing, and the improved high-frequency performance of the special stylus shapes may often justify their use.

The next problem faced by the cartridge is transferring the stylus motion to its voltage generator. This is usually done through a stiff, light cantilever with the stylus at its free end. Many of the important differences between cartridges are in the design of this small, almost invisible part. The actual generating system(moving iron, moving coil, etc.) is the least important consideration, since there are really no significant differences, from the listener's standpoint, between any of the systems currently in use.

If you have guessed that major advances in record-playing technology are unlikely to appear in the near future, you are probably right. What is needed is probably a totally new system, such as one in which the information is sorted digitally on the disc, or a pickup that does not contact the record physically, such as one using a laser beam. Either of these offers at least the possibility of a major improvement in record-playing quality, in contrast to the rather subtle, usually marginal, improvements resulting from the many "new" cartridges that appear. I see little likelihood that either of these radical innovations will become a commercial reality in the near future, though.

(3) *Tape Recorders.* Like record players, today's tape decks do the impossible, seemingly with ease and at a relatively modest cost. (If you doubt that, take a good look at—and listen to—a modern cassette deck.) Cassette tapes have been responsible for much of this progress, and the pattern seems likely to continue for some time. The ferric powder tapes that have been under development by several manufacturers, and should soon be ready for the market, represent a greater advance beyond chromium-dioxide tape than the latter did beyond the ordinary ferric-oxide tapes of five years ago. I can conceive of high-quality cassette decks that will fully rival present-day open-reel decks in their headroom, noise, distortion, and frequency response characteristics. Perhaps this will not occur in 1978, but it is visible on the horizon.

Open-reel tape technology, as it applies to home use, really has no need of improvement. Smaller machines, like the Pioneer Model RT-707 tested this month, may help open-reel to keep its place in deluxe home music systems. We will certainly see digital tape recording grow in professional applications. (It is already available, though at a rather high price.) The possibility of making tape recordings with arbitrarily great dynamic range and arbitrarily low distortion is too attractive to be ignored, however, and I have no doubt that eventually the advanced amateur recordist will be able to buy a digital tape recorder surpassing anything presently available. It is hardly likely that this will be a factor in the home market for a few years, however.

As for the Elcaset, I find my crystal ball rather uninformative. So far, there have been no signs of this new tape format's making any real inroads into the cassette or open-reel markets, or even carving out its own niche. We have to wait and see what happens.

(4) *The Electronic Components.* Without meaning to slight the efforts of the many engineers working on "new and improved" amplifiers, tuners, and receivers, we can hardly expect to see a substantive improvement in the sound qualities of these components. They are all so much better than the program material or the other parts of the hi-fi reproduction system that further reduction in distortion, of any kind, is a fruitless exercise. Of course, that will in no way hinder the development of new products, some of which may even have hitherto unimagined features. We fully expect to be impressed by them as they make their appearance, but we do not expect them to sound much different.

(5) *The Influence of Computers.* More accurately, this should be called the application of microprocessor technology to home entertainment products. This is a far larger field than can be covered here, spanning the range from digitally tuned, or programmed TV receivers and video games to the ADC Accutrac turntables and the new Sherwood Micro CPU 100 FM tuner. The latter two items are of special interest to us as audio enthusiasts. They represent early efforts to marry the memory and control abilities of a microprocessor to standard audio components.

As those who have followed audio developments should know, the Accutrac system allows the bands recorded on a phonograph record to be played in any sequence, according to a program entered into its digital memory. Using an optical sensing system in the cartridge, it counts the unrecorded spaces between bands as the motor-driven tonearm passes over the record. In its initial version, this was an expensive direct-drive record player, but the newest Accutrac model is half the price of the original. In addition to its track-selection ability, it can change records in either direction by transferring previously played discs from the platter to the stack on the spindle! Clearly, the possibilities of this technique are virtually limitless, and we can expect the price of such record players to drop appreciably as time goes on.

A somewhat similar concept is used by Optonica in one of its cassette decks to skip unwanted segments of recorded tapes. So far, it has not been carried to the same degree of refinement as the Accutrac record players, but there is no reason why it cannot be, and it probably will.

As for the Sherwood tuner, this $2000 unit is far beyond the means of most audiophiles. Its computer memory controls the frequency synthesizer that tunes it, and can be programmed to display the call letters of any stations on any of its approximately 50 channels. Not many people will spend $2000 for an FM tuner, no matter how fine its performance, merely

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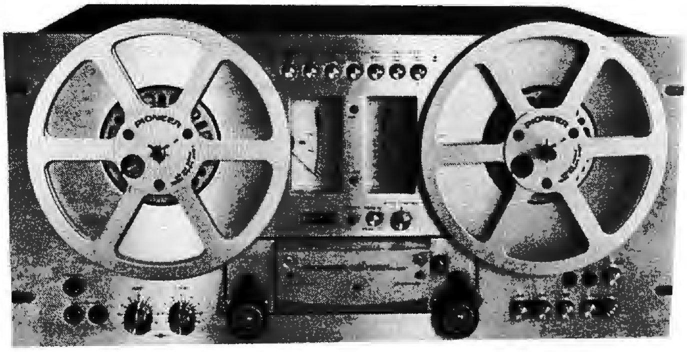
to get such a convenience feature, but the rate at which microprocessor prices are dropping makes it inevitable that this and other equally remarkable facilities will eventually be available at a fraction of their present prices.

Everyone is free to imagine the automatic control features he or she would like to see in a stereo receiver or any other home-entertainment audio device. It is a safe bet that anything you might envisage, and lots more, will ultimately be designed into audio components in almost all price brackets. These features may not make the system sound appreciably better, but they will certainly make it more fun for all of us to use!

PIONEER MODEL RT-707 BIDIRECTIONAL TAPE DECK

Moderately priced, open-reel machine features compact design and four tapeheads.



The new quarter-track, open-reel stereo tape deck from Pioneer, the Model RT-707, isn't much more costly than a good-quality cassette deck, yet it offers playback capability in both directions of tape motion. The three-motor, solenoid-actuated transport contains four tape heads, three of which provide full erase, record, and playback capabilities in the forward direction. The fourth tape head is for playback only in the reverse direction. The direction of tape motion can be selected manually or automatically, the latter with conducting foil on the tape leader.

The deck measures 19"W × 14"D × 9"H (48 × 35.6 × 35.6 × 23 cm) and weighs 43.6 lb (19.8 kg). It accommodates 7" (17.8-cm) diameter tape reels. Nationally advertised value is $575. (The deck is also available without the reverse-play capability as the Model RT-701 for $525.)

General Description. The capstan is driven by a direct-drive ac servo motor similar to the motors used in deluxe record turntables. This eliminates the need for belts and pulleys in the transport drive mechanism. Each tape reel hub has its own six-pole induction motor.

An interesting feature of this tape deck is an "Auto-Repeat" system that changes from reverse to forward play when the index counter returns to 0000 and the REPEAT button is engaged. Although this is not the same as the memory rewind used in some cassette decks (it operates only in the reverse-play mode, not in high-speed rewind), it and the foil sensing system allow a tape or any portion of it to be repeated indefinitely.

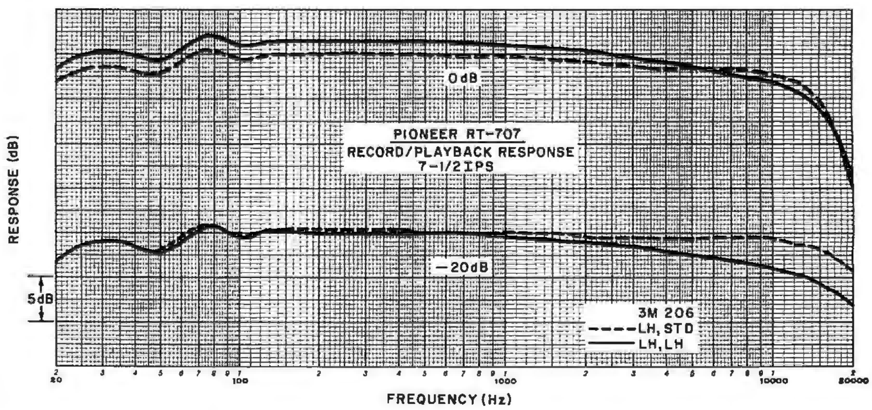
In spite of the deck's rather compact panel (which is slotted for rack mounting should one wish to do so), most of which is occupied by the tape reels, there is a full complement of controls. The controls are grouped for logical operation and good accessibility.

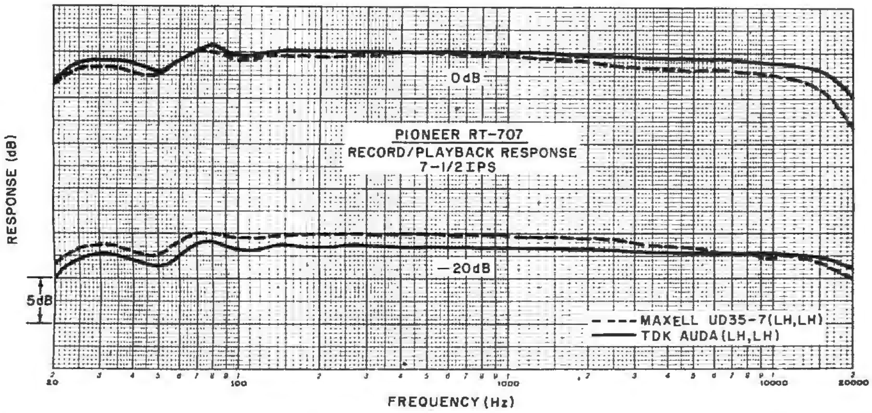
The tape is loaded in a straight line across the tape heads after two tensioning arms have been locked in their upward positions. Although there is a tension arm and a pinch roller on both sides of the head assembly, a single capstan drives the tape in both directions. Available speeds are 7½ and 3¾ ips (19 and 9.5 cm/s). The direct-drive motor changes speed and reverses direction of rotation almost instantly when the controls are operated.

Pushbutton switches located to the right of the head assembly control the transport mechanism through solenoid actuators. They include the usual forward and reverse high-speed functions, a PLAY button with separate REC (record) interlock button, and a STOP button. There are also a fast-acting PAUSE control and two tape direction selector buttons. The latter have illuminated arrows to indicate the direction of tape motion. (The deck can be controlled by a timer switch in the power line for unattended recording and playback.)

At the lower left of the panel are two microphone jacks and a stereo headphone jack. Near the jacks are MIC and LINE recording level controls, each a concentric pair for the two channels. The two sources can be mixed. Just above the tape heads are the reset button for the tape counter, REPEAT button, and a center-detented PITCH control that per-

Record/playback response with Scotch 206 tape using "LH" for bias in both cases and "LH" and "STD" for equalization.





Record/playback response with TDK Audua and Maxell UD35-7 tapes with "LH" bias and equalization.

mits the speed of the capstan motor to be varied over a nominal ±6% range during playback only. Screwdriver access holes in the tape head cover make it easy to adjust the azimuth of the recording and two playback heads.

At the top of the panel, between the tape reels, are seven pushbutton switches. These control POWER, SPEED, TAPE/SOURCE monitoring, BIAS and EQ (equalization) with STD and LH positions, and REC MODE . There are two switches for the latter, and they must be engaged to record on either or both channels and make it possible to record on one channel while playing back on the other for special effects.

Below the buttons are two large illuminated level meters with vertically oriented scales. Between the meters are red REC and green PAUSE LED's.

On the rear panel of the deck are the line input and output jacks and two control shafts for setting the playback levels. Each control has a detented reference point. The controls allow adjustment of the playback output level above and below the reference points. There is also a single accessory ac outlet on the deck's rear panel.

The tape deck is supplied with a metal take-up reel, signal cables, head cleaning kit, splicing tape, and sensing tape.

Laboratory Measurements. Although the instruction manual supplied with the deck states that performance specifications are based on the use of Scotch 206 tape, our test deck had been set up for TDK Audua tape. Most of our test were made with both tapes, as well as other tapes of comparable quality. The differences between the tapes were not great.

A LINE input of 35 mV or a MIC input of 0.18 mV produced a 0-dB recording level at maximum gain. With the controls on the deck's rear panel set to their detented points, the playback outputs were 580 mV with the TDK and 450 mV with the Scotch tapes. At the maximum control settings, these figures were 800 and 700 mV, respectively.

The playback frequency response, measured with the Ampex 31331–01 tape at 3¾ ips, was within ±1.5 dB over the 50-to-7500-Hz range of the tape. The frequency response at 7½ ips, using the Ampex 31321–04 tape, was within ±0.5 dB from 50 to 5000 Hz in the forward direction. It rose to +2.5 dB at 15,000 Hz. In the reverse direction, the response was flatter and was within ±0.5 dB from 50 to 15,000 Hz.

The instruction manual lists recommended settings for the recording BIAS and EQ switches for many types of tape. These were correct for TDK Audua tape. However, in the case of Scotch 206 tape, it was necessary for us to use the STD instead of the LH setting of the EQ switch to obtain the flattest response. (We assume "LH" means the "low-noise/high-output" term generally used for premium tape.) Using LH bias and equalization with TDK tape, the record/playback frequency response at 3¾ ips was down 4 dB at 30 and 14,000 Hz at a −20-dB recording level. At a 0-dB recording level, tape saturation reduced the high-frequency output to −4 dB at 10,000 Hz. At 7½ ips, the −20-dB response was within ±2 dB from 20 to 24,500 Hz, while at 0 dB, it was within ±2 dB from 20 to 18,000 Hz.

When we used the Scotch tape with STD equalization, which applies a higher recording level at high frequencies, the 7½-ips frequency response at −20 dB was down 3 dB at 20 and 18,000 Hz and down 5 dB at 20,000 Hz. With LH bias and equalization, Maxell UD35–7 tape yielded roughly similar results. By a small margin, Memorex Quantum tape delivered the widest overall frequency response, within ±1.5 dB from 20 to 23,000 Hz and ±3 dB from 20 to 29,000 Hz. Impressive as these figures are, the audible differences between the various tapes were very slight.

At a 0-dB recording level and 7½-ips tape speed, the playback distortion was about 0.23% with Memorex and TDK tapes and 0.34% with Scotch tape. The reference 3% distortion level was reached with inputs of +14, +12, and +12 dB, respectively. The S/N ratios relative to these input levels were very similar for the tapes used during the tests, although the actual numbers depended on the weighting curve used for the measurements. By a very small margin, Scotch 206 tape gave the best overall S/N performance, measuring 65 dB unweighted, 69.5 dB with IEC A weighting, and 66.7 dB with CCIR weighting. This is very substantially better than the manufacturer's 58-dB spec. At 3¾ ips, each of these figures was down by about 3 dB. Through the microphone input and at maximum gain, the S/N was down 8 dB, but at normal gain settings, there was negligible degradation of noise performance on microphones.

The unweighted rms flutter was 0.08% at 3¾ ips and 0.065% at 7½ ips in a combined record/playback measurement. The wow was less than the 0.01% residual of our test tape. Using Ampex flutter test tapes, the flutter in the forward direction was 0.09% at both speeds. In the reverse direction, when the capstan was on the "supply" reel side of the heads, it was 0.17% and 0.12%at 3¾ and 7½ ips, respectively.

The playback speed was exactly the same as the recording speed when the PITCH control knob was centered. The full vernier control range was from +9.2% to −7.6%, which is even wider than the semitone range claimed. In fast forward, the transport moved 1800′ (550 m) of tape from end to end in 89 seconds. In rewind, it required 102 seconds.

The meters were calibrated so that 0 dB corresponded to a recorded flux level of approximately 180 nWb/m (nanowebers/meter). The ballistic response of the meters was slightly slower than VU standards. The meters indicated 90% of steady state on 0.3-second tone bursts. The fixed headphone level was fairly good, using 200-ohm phones.

User Comment. The electrical performance of the Model RT-707 is typical of moderately priced open-reel tape decks. At 7½ ips, the headroom of the deck over the entire audio range is adequate for high-quality live recording without the compression that limits the successful use of cassette recorders for the same purpose. The 3¾-ips performance of this deck is comparable to that of a medium-priced cassette deck.

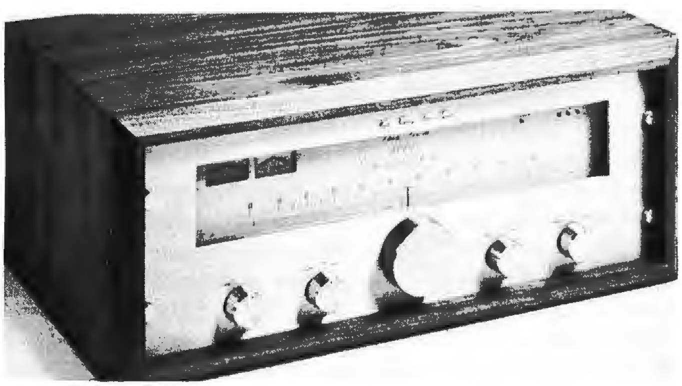
Although the very complete and informative instruction manual suggests BIAS and EQ switch settings for a number of tapes, it wisely adds that different settings should be tried if the sound is not to the user's liking. We recommend beginning with the suggested settings and recording interstation hiss from an FM tuner at a fairly low level of −10 dB or so. With the monitor button, alternately listen to the incoming signal and the playback from the tape. At its optimum settings, the tape deck is capable of virtually perfect recording and playback of this very demanding test signal. If there is any appreciable difference between the input and output, try other switch settings to determine the best operating conditions for a given tape.

Ease of installation of the Model RT-707 is a key factor in the appeal of this deck, as compared to many other open-reel tape recorders and decks. With cassette decks becoming larger and Elcaset decks larger still, the surprisingly compact Model RT-707 comes into direct competition with these tape formats insofar as size is concerned. The Model RT-707 is easy to use, requires no critical adjustments, and proves that open-reel tape is still a part of the consumer hi-fi scene.

CIRCLE NO. 101 ON FREE INFORMATION CARD

PHASE LINEAR MODEL 5000 FM TUNER

Built-in expander increases dynamic range of program material.



HIRSCH-HOUCK LABS REPORT

Some years ago, Phase Linear began to introduce audio components that had some then unique noise-reduction and dynamic-range restoration systems. The first was a preamplifier, which was followed by an add-on accessory that could be used with just about any amplifier or receiver. The recently introduced Model 5000 FM tuner follows in this tradition, featuring its own unique noise-reduction and dynamics restoration system.

The Model 5000 is obviously styled as a companion to Phase Linear's Model 4000 preamplifier and Model 400 basic power amplifier, sharing the same front panel size and finish. Although its 19"W × 7"H (48.3 × 17.8 cm) panel is larger than would be expected on an FM tuner, the 10" (25.4-cm) depth allows for easy mounting on shallow shelves and in shallow cabinets. In spite of its size, the tuner weighs only 17 lb (7.7 kg). Its nationally advertised value is $500.

General Description. Phase Linear did not supply a schematic diagram or even a description of the circuits in the tuner. However, a block diagram in the user's manual that accompanies the tuner indicates the use of a phase-locked-loop (PLL) multiplex decoder and an IC that combines the i-f amplifier, limiter, and quadrature detector circuits on a single chip.

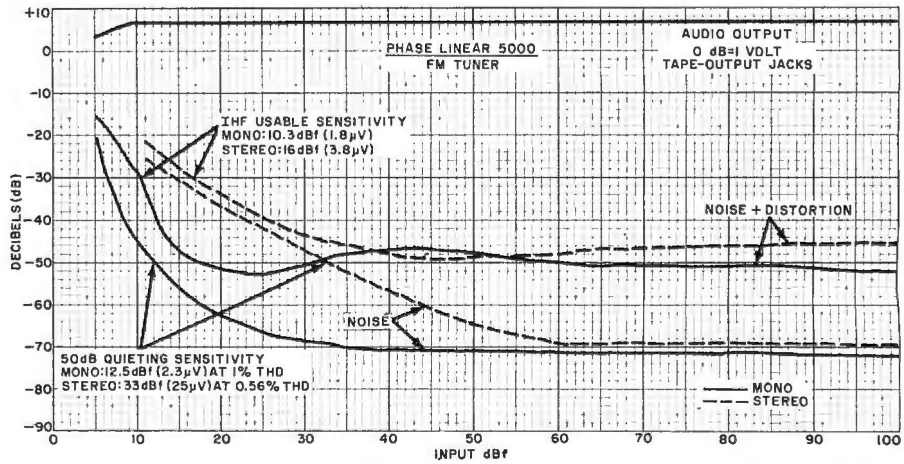
As befits a tuner with an oversized front panel, the Model 5000 has one of the longest dial scales we have ever seen. It measures some 10¼" (26 cm) of calibrated scale in all. Its frequencies are marked at the 200-kHz intervals used in the U.S., with the short lines at only the odd-value frequencies. Presumably, the dial pointer will be directly aligned with one of the marks whenever a station is tuned. There are also a longer accented line at every megahertz interval and a numerical calibration at 2-MHz intervals.

The tuning scale is on a satin-gold subpanel that matches the finish of the main panel. A large glass window covers the dial, tuning meters, and a four-LED display. The meters indicate relative signal strength and center-channel tuning. One of the LED's is used to indicate STEREO reception, while the other three LED's are used as a multipath indicator. The ZERO LED in the multipath indicator system glows when there is negligible multipath distortion on the signal. The MAX LED comes on when severe multipath distortion is experienced. Obviously, the center LED in the display comes on to indicate multipath conditions between the two limits.

The tuning knob operates a smooth flywheel mechanism. Its 2¼" (5.7-cm) diameter is quite large. This knob is centered below the dial window on the front panel. Flanking it are four smaller knobs labelled POWER, EXPANDER, MUTING (threshold), and STEREO/MONO MODE.

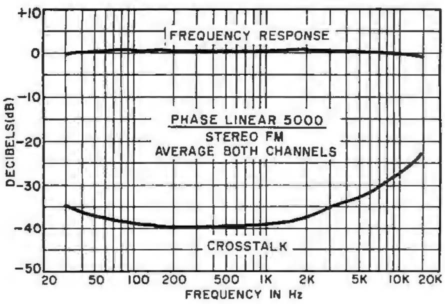
The unique EXPANDER feature is designed to complement, as much as possible, the compressor characteristics used in FM broadcasting to restore some of the lost dynamics of the program. (FM stations typically apply some degree of compression or peak limiting to prevent excessive deviation while retaining a reasonably high average signal

Noise and sensitivity curves for FM section of tuner.



modulation level.) In addition to OFF, the EXPANDER switch has settings for 4 and 9 dB of expansion.

The rear apron of the tuner has two sets of audio outputs. One is at a nominal 2-volt fixed level and the other is adjustable from 2 volts down, the latter via a pair of small knob controls positioned just below the output jacks. The fixed outputs are meant to be used for off-the-air tape recording.



Frequency and crosstalk averaged for both channels.

Two slide switches, one to dim the illumination of the tuning dial and the other to permit selection of either 75 or 25 μs deemphasis (25 μs is required when using an external Dolby noise reduction adapter), are also on the rear apron. Other items on the rear apron include antenna terminals for 300- and 75-ohm antennas and a coaxial connector for 75-ohm antennas.

Laboratory Measurements. The IHF sensitivity of the tuner measured 10.3 dBf (1.8 μV) in mono and 16 dBf (3.8 μV) in stereo. The 50-dB quieting sensitivity measured 12.5 dBf (2.3 μV) and 33 dBf (25 μV) in mono and stereo, respectively. All the measured sensitivities were better than the tuner's rated performance by a comfortable margin.

The output signal-to-noise (S/N) ratio of the tuner with a 65-dBf (1000-μV) input was 71.5 dB in mono and 69 dB in stereo, which is also better than rated. The only specification the tuner failed wholly to meet was that of distortion, which is rated at 0.2% in mono and 0.3% in stereo. Within the normal tuning conditions indicated on the center-channel meter, the lowest distortion was 0.3% in mono and 0.48% in stereo, at a 65-dBf input. By tuning outside the center area of the meter scale (which also caused the multipath lights to glow), the distortion could be reduced to between 0.1% and 0.2%, but this is obviously not a normal operating condition for this or any other tuner.

The stereo performance of the tuner was good. Its frequency response was within 1 dB overall from 30 to 15,000 Hz. Channel separation was 38 to 40 dB through much of the audible range and was a good 34.5 dB at 30 Hz and 23 dB at 15,000 Hz. The 19-kHz pilot carrier was 70 dB down in the audio outputs. The stereo distortion, with L − R modulation, was 0.7% at 100 Hz, 0.4% at 1000 Hz, and 0.08% at 6000 Hz. Tuner hum was a very low −76 dB.

The stereo switching threshold was at about 9 dBf (1.5 μV). The muting threshold could be adjusted to any value up to 42 dBf (70 μV). The capture ratio was outstandingly low: about 1 dB at 45 dBf (100 μV) and 0.8 dB at 65 dBf. AM rejection was no more than fair (50 dB) at 45 dBf, but it improved to a good 64 dB at 65 dBf. Image rejection, specified as 110 dB (the limit of our test facility), was obviously greater than that, since we could find no trace of an image response. The alternate-channel selectivity was 55 dB above the signal frequency and 67 dB below it, for an average of 61 dB. Adjacent channel selectivity was 4.9 dB.

We judged the expander and multipath indicator features by listening, since conventional measurements are not practical with such features.

User Comment. In general, the "handling" properties of the tuner were excellent. The tuning mechanism was silky smooth, and the muting action was free of noise bursts when passing through a signal. The multipath indicators were disappointing, however, since at no time did they indicate multipath distortion on any of the 50 or so stations receivable at our test location. (Past experience with oscilloscope multipath indicators has shown us that many of these stations have severe multipath distortion and most have some.)

Although a highly resolved dial is used on the Phase Linear 5000, the dial on our test sample indicated about 100 kHz higher than the station frequency. Such an error on most tuners would rightly be considered negligible, since the pointer width itself often corresponds to 200 kHz or so. This was probably due to an improperly set pointer, or to a shift of pointer position during shipment, narrowly preventing our sample from being the most accurate nondigital tuner (in respect to frequency calibration) that we have seen.

The minuscule discrepancies between the distortion measurements we obtained and the published figures probably indicate a misalignment in the tuner

circuits. In any event, they make no difference to the human ear. Furthermore, measurements were less than the distortions inherent in FM programs. Although they prevent us from classifying the Model 4000 as a "super tuner," another sample might earn this name.

The expander circuit proved to be effective and worthwhile. In the 4-dB setting, it raises the average and high-level modulation quite audibly, but does not appear to affect the low-level program or the background noise. The 9-dB setting appears to provide no further increase in audio level. At first, we thought the expander was not functioning properly. However, during quiet moments in the program, when we switched from 4 to 9 dB, there was a definite drop in the audible background noise level. Presumably, this drop of nominally 5 dB, combined with the expansion boost of 4 dB yields an added 9 dB of dynamic range in reception. There was no audible sign of the expander's operation, such as noise "swishes," and we preferred to listen with the full 9-dB expansion.

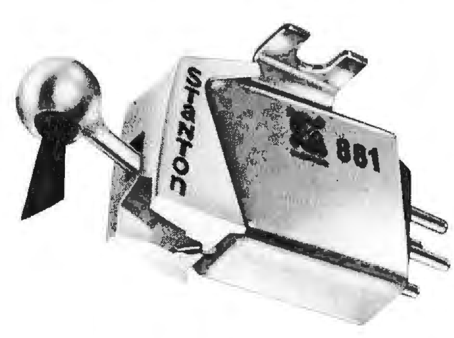
Phase Linear does state that the operating characteristics of the Model 5000's expander are optimized for FM reception conditions, and that it should not be used with any other type of expander, such as the Peak Unlimiter and Downward Expander in the company's Model 4000 preamplifier. Although this might appear to add redundancy to a system made up entirely of Phase Linear units, it really adds versatility, since the other signal processing circuits are optimized for disc recording conditions.

In sum, the principal *special* attraction of the Model 5000 is its expander. As we have said, this works very well indeed. In other respects, the Model 5000 is not significantly different (neither better or worse) than a number of good, not inexpensive FM tuners on today's market. If the expander seems like a trivial feature (it is not), remember that much of Phase Linear's reputation has been based on the ability of its signal-processing devices to make an existing signal sound *better*, instead of merely to pass the signal through without any degradation of its quality. This is precisely what the Model 5000 can do.

CIRCLE NO. 102 ON FREE INFORMATION CARD

STANTON MODEL 881S PHONO CARTRIDGE

New Stanton transducer merits its top-of-line position.



HIRSCH-HOUCK LABS REPORT

Stanton's whole stereo cartridge line has for some time been headed by the company's "Calibration Standard" models. These phono cartridges are designed to give flat frequency response, wide channel separation, and low distortion, while remaining rugged enough to be used in professional recording and broadcast studios. The 681 series cartridges were Stanton's Calibration Standards until the recent announcement of the new Model 881S cartridge.

Although the Model 881S physically resembles other cartridges in the Stanton line, even to including a hinged dust brush as part of the removable stylus assembly (to remove surface dust from the record), it is a totally redesigned product. For example, instead of the moving-iron transducer principle used in other Stanton cartridges, the Model 881S employs a moving-magnet principle. Although its stylus is physically interchangeable with some of the company's other products, it will operate properly only in the 881S body.

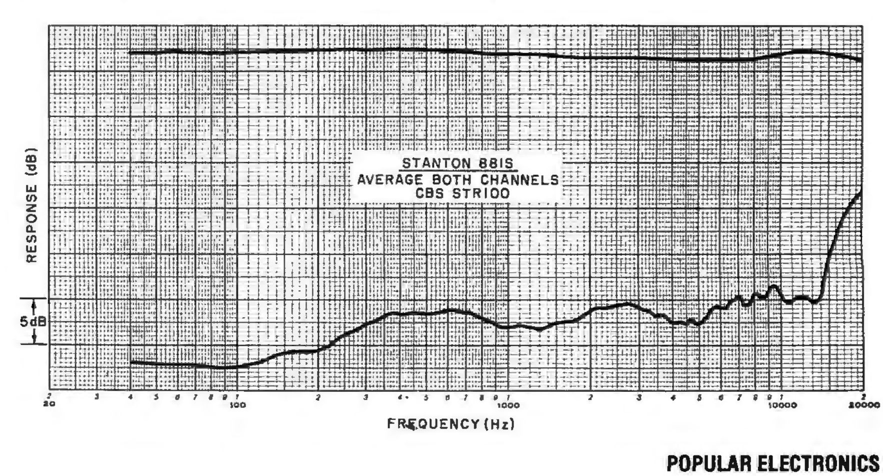
Each Model 881S cartridge is supplied with calibration data (not a curve) that shows the variation in response over the audio frequency range, the output voltage, and the inductance and resistance of its coils. A small metal "pill box" is provided, for storing extra styli. (As with other Stanton cartridges, 1- and 2.7-mil styli are available for using the Model 881S to play mono LP and 78-rpm discs.) Nationally advertised value is $150.

General Description. The stylus cantilever carries a tiny magnet formed from a rare-earth metal. The magnet is said to be 10 times stronger than conventional magnets of the same size. Because of the extra energy provided by the magnet, the coils of the Model 881S cartridge have fewer turns and lower inductance than those used in other model cartridges. This makes the Model 881S less sensitive to the effects of loading capacitance, which can have a considerable effect on the high-frequency response of most phono cartridges. At the same time, the output voltage of the new cartridge is maintained at a high level (nominally 0.9 mV/cm/s).

At the other end of the stylus cantilever is a nude diamond "Stereohedron" stylus, the design of which is derived from the special stylii developed for playing CD-4 discs. The Stereohedron has a greater contact area along the sides of the record groove than an elliptical stylus. This reduces record wear while providing superior high-frequency tracking ability.

The effective mass of the stylus system is rated at only 0.2 milligram. The rated tracking force is 1 gram ±0.25 gram. As with other brush-equipped Stanton cartridges, the Model 881S must be operated at a 1-gram greater downward force to overcome the upward force of the brush and bring the stylus into contact with the record. In a typical installation, the tonearm would

Left and right response and crosstalk using CBS STR100 record.



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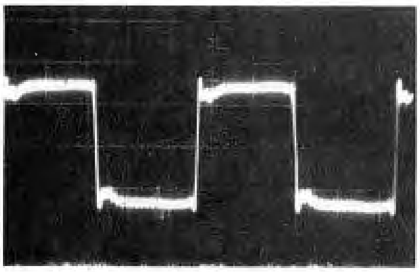
be set for an indicated 2-gram downward force to yield a 1-gram force in operation. If desired, the brush can be removed, in which case, the force adjustment is performed as with any cartridge.

Laboratory Measurements. The Model 881S phono cartridge was tested in the tonearm of a typical medium-priced record player. We loaded the cartridge with 47,000 ohms in parallel with 290 pF of capacitance. (Rated nominally at 275 pF.)



Square-wave response using CBS STR112 test record.

The standard level bands of the CBS STR100 record (3.54 cm/s at 1000 Hz) produced an output of 4.3 mV from one channel, and 4.7 mV from the other. The channel unbalance of 0.8 dB was well within Stanton's 1 dB tolerance. The vertical tracking angle of the stylus was 22°. Preliminary tracking tests revealed that the cartridge was well above average in this respect. The 30 cm/s, 1000-Hz tones on the Fairchild 101 record were playable at a tracking force of only 0.5 grams. There was some distortion, in the form of peak clipping, but this was not improved by higher forces. This indicates that the recorded amplitude was beyond the design limits of the cartridge.

At 32 Hz, the very high levels of the Cook Series 60 record were played at 0.4 gram, suggesting the very high compliance of the cartridge's stylus system. Finally, the 300-Hz tones of the German Hi Fi Institute record could be played through the 80-micron level at 0.5 gram and through the maximum level of 100 microns at 0.75 gram.

The cartridge produced a frequency response that was flat within ±1 dB from 40 to 20,000 Hz. Cutting the load capacitance in half had a negligible effect on the overall response. Increasing it to more than 500 pF produced a slight peak at 10,000 Hz and a drop in output at higher frequencies. However, the overall ±2.5-dB variation from 40 to 20,000 Hz was *still* very good. Clearly, the cartridge is not dependent on a critical load impedance for its fine frequency response.

The channel separation was between 20 and 35 dB over the full frequency range from 40 to 20,000 Hz. The low-frequency response in the record player's tonearm was at 8 Hz, with an amplitude of about 10 dB. The square-wave response from the CBS STR112 record was excellent, with only a slight overshoot and negligible ringing.

We measured the tracking distortion of the cartridge with the Shure TTR-102 test record for IM distortion and the Shure TTR-103 record for high-frequency tracking of shaped 10.8-kHz tone bursts. At the rated 1-gram force, the IM distortion was about 2% at lower velocities (7 cm/s) and only 5% at the maximum of 27.1 cm/s. Most cartridges begin to exhibit severe mistracking at the highest levels on this record, especially near the lower part of their tracking force range, but the Model 881S never mistracked. On the 10.8-kHz tone bursts, the repetition-rated distortion was about the same as we have measured on many other good cartridges.

For a subjective judgment of the tracking ability of the cartridge, we played the Shure "Audio Obstacle Course-Era III" record. In this test, the cartridge lived up to expectations, tracking all levels of all selections on the record without audible mistracking at its minimum rated force of 0.75 gram (except the highest level of a bass drum, which required 1 gram).

User Comment. For extended listening tests, we installed the cartridge in the tonearm of a Dual Model 701 record player and operated it at 0.75 gram. We never sensed any strain or incipient mistracking at this force.

The brush was removed at one point in our evaluation and rather than risk damaging the stylus to replace it, we left it off for the remainder of the evaluation.

This is one of the most neutral and uncolored cartridges we have listened to. It sounds as flat as its frequency response curve implies and has an impressive freedom from audible tracking distortions of any kind. It provided a revelation when listening to some of our older, well-worn discs, providing a freshness in their sound that we had not suspected was there. It is quite probable that this was due, at least in part, to the Stereohedron stylus, which rides lower in the groove than a conical or elliptical stylus and thus contacts a portion of the groove modulation that has not previously been damaged by stylus contact. Whatever the explanation, we feel that the Model 881S merits its place at the top of the Stanton line.

BY BILL GREEN

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DECEMBER 1977

POWER YOUR PROJECTS WITH SOLAR ENERGY!

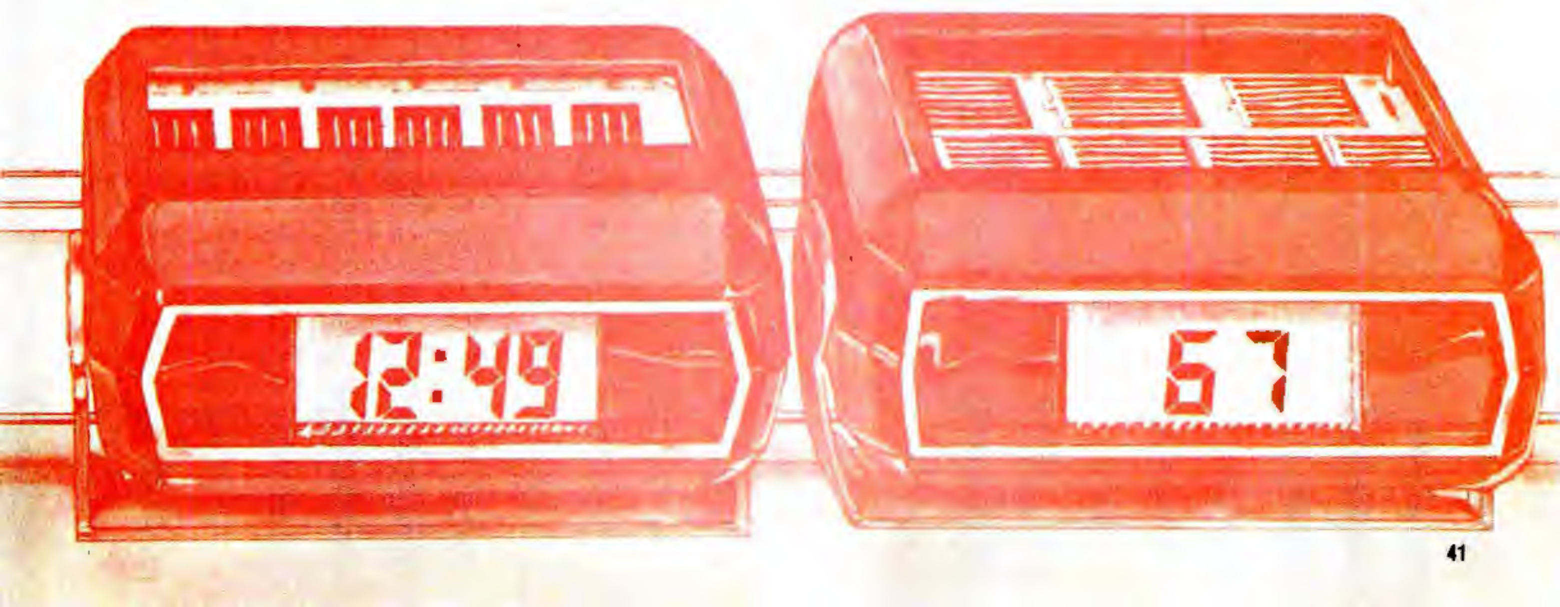
DIGITAL CLOCK AND THERMOMETER PROJECTS USE SUN OR ARTIFICIAL LIGHT TO AUTOMATICALLY RECHARGE BATTERIES.

THE IDEA of building a simple solar-cell power supply for small appliances in your home is not as far-fetched as you might think. Here is a supply that can deliver 10 volts dc at 100 mA for one hour. Alternatively, it can deliver 10 mA for 11 hours. The power capability of the supply is sufficient to drive a transistor radio, emergency light, smoke detector, and other types of low-to-medium-power devices.

To illustrate typical uses of the solar-cell power supply, this article also presents construction details for a digital clock calendar and a digital thermometer. Both projects employ CMOS IC's and liquid-crystal displays to minimize the drain on the solar-cell power supply. The two projects employ variations of the basic solar array to recharge (either by sunlight or artificial lighting) their internal nickel-cadmium cells.

Solar Cells. Silicon solar cells are photovoltaic light sensors that convert incidental light directly into electrical energy. Solar cells have been used in all the earth satellites and space probes to keep the internal batteries "topped up." Such solar cells have formed the exterior "skin" of many satellites; and in other cases, such as the Skylab, they have been on "wings." They have also been used to power electronic equipment far from a convenient source of power.

The impinging photons of light energy break a valence bond within the pn junction area of the silicon cell and create electron-hole pairs that cause a potential difference across the cell. The cells are designed to maximize the light-sensitive nature of the pn junction. Those used in the projects in this article are shallow-diffused types that have a special blue coating to enhance the re-



sponse at the blue end of the visible-light spectrum. The emission-distribution and response curves of some light sources and sensors are illustrated in Fig. 1.

When coupled with some device (such as a rechargeable battery) that can store the electrical energy generated by a solar cell, the system can be used to power many different electrical and electronic devices at essentially no cost but the original investment. At night, the solar-cell array can be placed near a bright incandescent lamp to reclaim energy that would otherwise be wasted.

Solar-Cell Power Supply. This basic solar-charged power supply consists of up to 26 silicon solar cells, the actual number depending on the desired output voltage. The system can deliver up to 40 mA in bright sunlight. If all 26 cells are used, the terminal potential will be 10 volts (see Parts Lists for Solar-Cell Array).

The fully-charged NiCd cells used in this circuit can deliver about 100 mA of current for an hour (10 mA per hour for 11 hours, for a total of 110 mAh). Two or more of these supplies can be connected in parallel to deliver more current. Alternatively, two or more supplies can be connected in series to provide a higher output voltage.

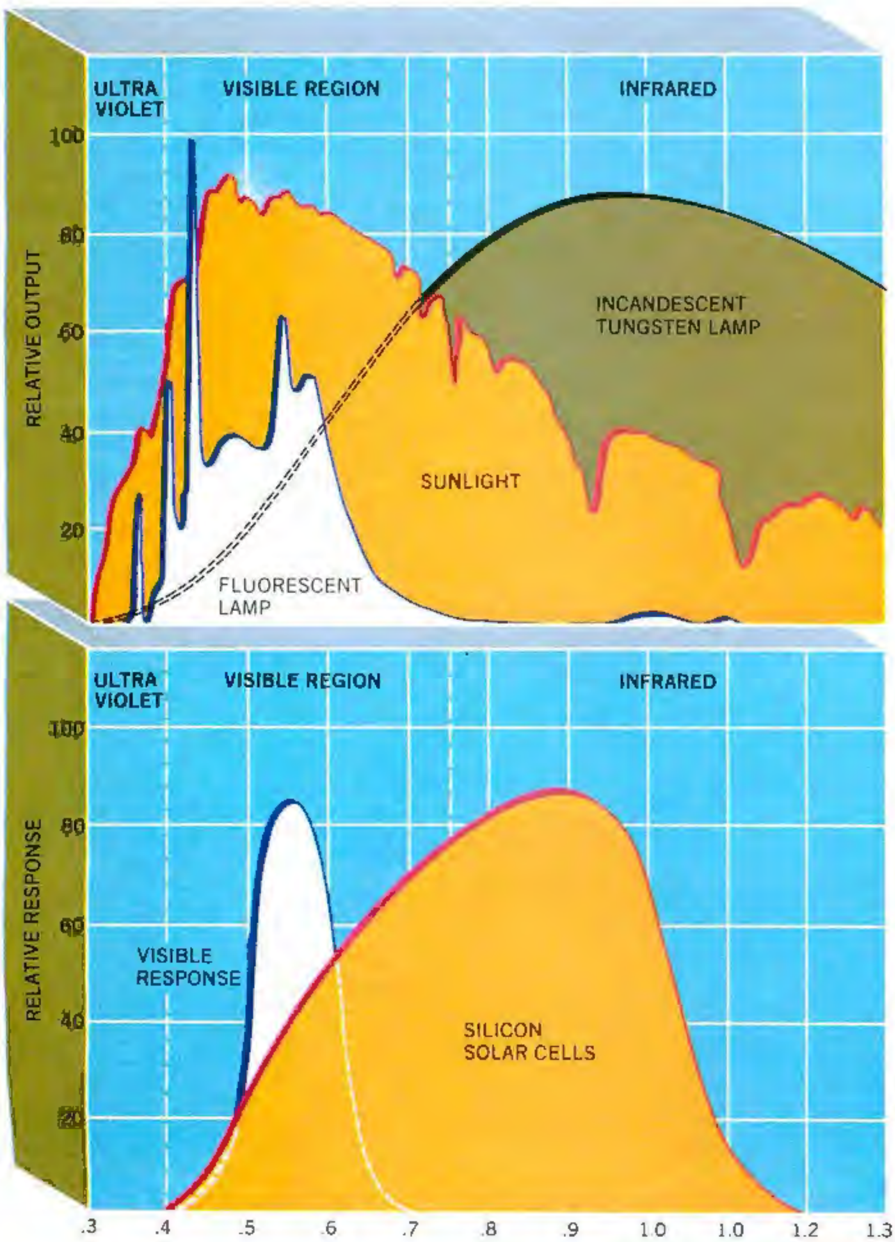


Fig. 1. Emission-distribution of some light sources compared to responses curves of some sensors.

Approximately 13 hours of exposure at a distance of about 8" (20.3 cm) from a 100-watt incandescent lamp or about five hours in direct sunlight should be sufficient to fully recharge the NiCd cells. If you live in a bright, sunlit area of the country, take care to prevent overcharging that can damage the NiCd cells. The maximum continuous charging rate to the cells in the supply should be limited to 10 mA.

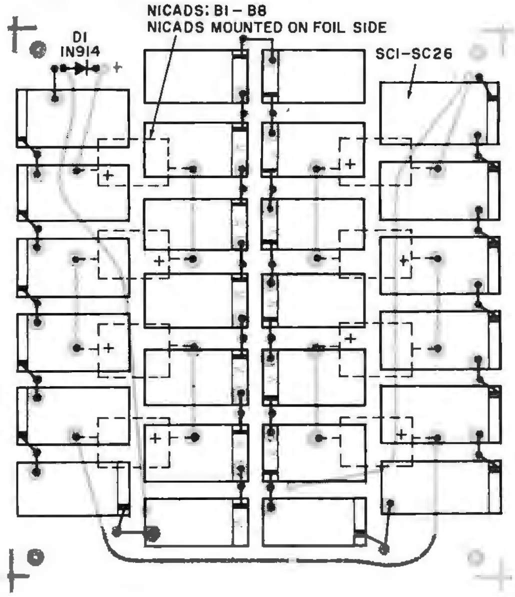
Construction. The supply can be assembled on a single-sided printed circuit board, the etching and drilling and component-placement guides for which are shown in Fig. 2. In this supply, the full complement of solar cells and nickel-cadmium cells is used.

Each solar cell has its light-sensitive surface finished in a deep blue color, with silver leads just under the surface and a thin metallic "land" along one edge. The upper metal land is the negative terminal.

The solar cells must be epoxied to the blank side of the pc board, making certain that the positive metal land on the bottom side of each cell is facing toward the large hole through the board at each solar cell location. Use a low-wattage soldering iron and fine solder for the wiring operation. Start from the diode end and very carefully solder a thin lead from the positive side of the adjacent solar cell to the pad at the diode's anode. Continue working very carefully with the soldering iron and interconnect each of the solar cells as follows. Solder a thin wire to the negative terminal of the cell. Pass this wire through the small hole near the cell and solder it to the positive terminal of the next cell through the large hole in the board. Repeat this procedure until all 26 cells are wired in series, with the final piece of wire connected to the negative terminal of the last cell at one end and to the "−" pad on the pc board at the other end.

Once all solar cells have been wired, you can test the array by connecting a dc voltmeter from the positive to the negative pads on the board and exposing the array to a bright source of light. The voltmeter should indicate at least 10 volts, depending on the brightness of the light source and the distance between the cells and source. Covering the solar-cell array with your hand should cause the pointer to swing downscale.

The positive terminal of each NiCd cell is identified by a small "+" or a "ring" at one end. Bear this polarity scheme in mind when you install the NiCd cells on the pc board.



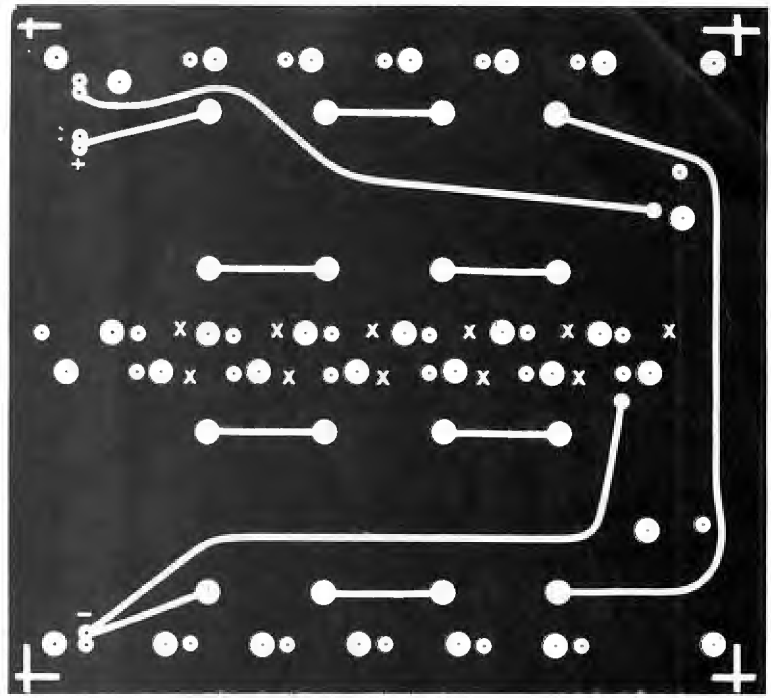


Fig. 2. Basic solar power supply with solar cells on nonfoil side of board and nickel-cadmium cells on foil side.

SOLAR-CELL ARRAY PARTS LIST

B1 through B8—100-mAh nickel-cadmium cell
D1—1N914 diode
SC1 through SC26—Sc-50 silicon solar cell
Misc.—Printed circuit board; epoxy cement; hookup wire; solder; etc.

Place the pc board assembly solar cell side down on your work surface and pretin with solder the pads to which the NiCd cells connect. Then pretin the ter-

CLOCK/CALENDAR PARTS LIST

B1,B2,B3—100-mAh nickel-cadmium cell (GE No. GCF100ST, rated at 1.2 V at 100 mAh, or similar)
C1—100-pF disc capacitor
C2—5-to-30-pF trimmer capacitor
C3—47-µF, 6-V electrolytic capacitor
D1,D2—1N 914 diode
DIS1—MLC200 liquid-crystal display (Motorola)
IC1—MC14440 LCD watch/clock (Motorola)
IC2—MC14584B hex Schmitt trigger (Motorola)
The following resistors are ¼-W, 10%:
R1—82,000 ohms
R2,R3,R4—1 megohm
R5,R8—100,000 ohms
R6,R11—470,000 ohms
R7—4700 ohms
R9—10 megohms
R10—560,000 ohms
S1,S2,S3—Normally open spst pubhbutton switch
S4—Normally closed spst pushbutton switch
SC1 through SC11—SC-50 silicon solar cell (0.4" × 0.4", rated at 40 mA at 0.4 volt)
XTAL—32,768-Hz crystal (miniature)
Misc.—Printed circuit boards (3); sockets for IC's and LCD; suitable enclosure; etc.

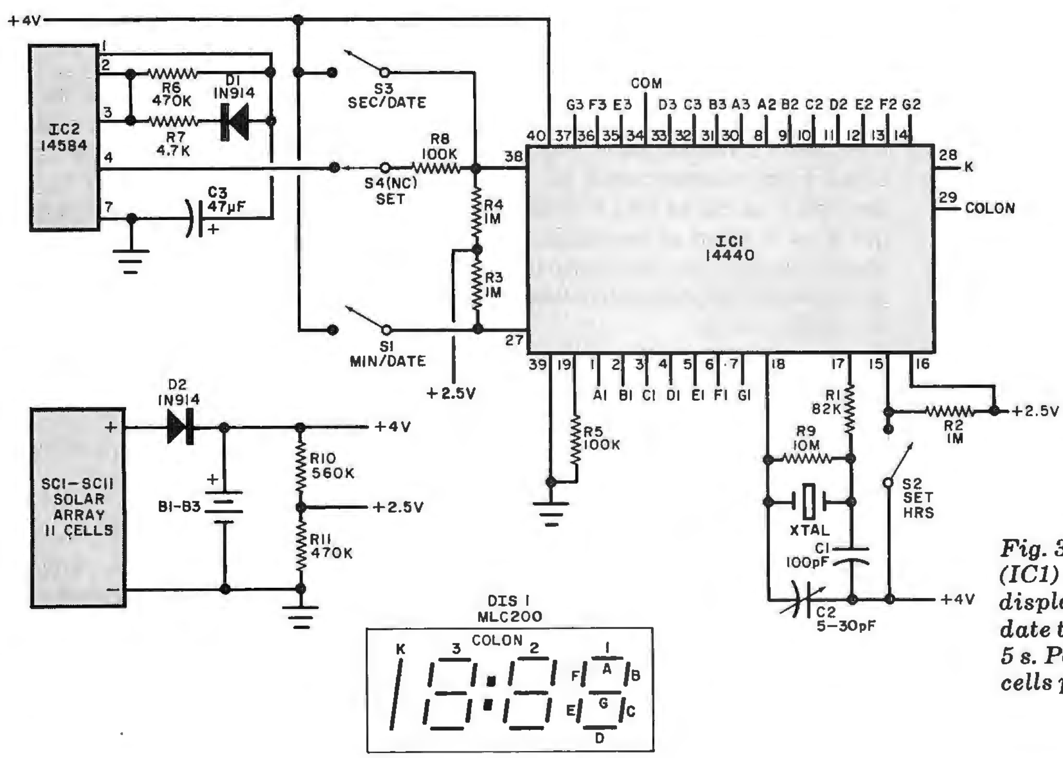
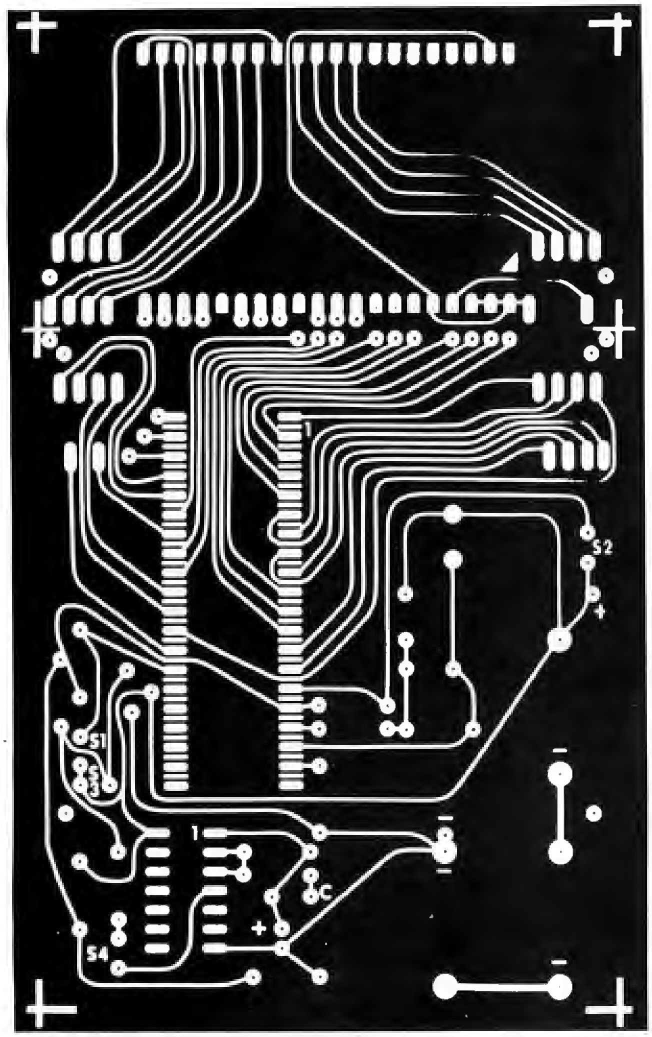


Fig. 3. Clock/calendar chip (IC1) drives liquid-crystal display. Oscillator causes date to appear about every 5 s. Power is from 3 NiCd cells powered by solar array.



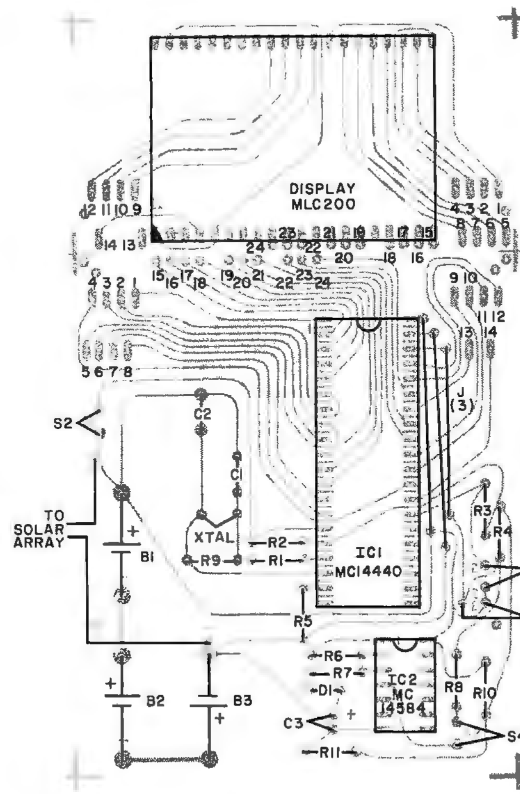


Fig. 4. Actual-size foil pattern for the clock main and display board is at left. Component layout is shown above. After completing the board, carefully separate the two parts.

minal tabs for all NiCd cells. Now, position the first cell on the pc board as shown in Fig. 2 and apply soldering heat to the top of one terminal tab to "reflow" the solder on tab and pc pad. Do not allow the cell to move until the solder sets. Then reflow solder the other cell tab to its pc pad. Continue this reflow soldering procedure until all NiCd cells are mounted on the pc board. When you are finished wiring in the NiCd cells, double check to make sure that they are properly polarized. Then install and solder into place diode *D1,* making sure that the cathode end goes to the pad labelled "C" on the board.

Finally, solder lengths of red and black insulated stranded 28-gauge hook-up wire to the positive and negative output pads on the board. These leads should be long enough to reach from the solar-cell power supply to the equipment the supply is to power. Twist the wires together to form a pair.

The power supply can be placed in a window or near bright indoor lighting and connected to the equipment it is to drive. It is important that you keep the supply in a location where it will receive enough light to keep the NiCd cells charged and provide enough current to make up for the power used by the equipment being powered by the supply.

Solar-Powered Clock. A CMOS/liquid-crystal-display clock, such as the one shown schematically in Fig. 3, is a useful solar-powered project. Its current demand is as low as 25 μA. If its solar-cell array is given an occasional exposure to sunlight, the clock should operate for a very long time without attention or a battery charge.

How It Works. Clock chip *IC1* contains all the electronics required to drive a liquid-crystal display and to count the time and date. The crystal (*XTAL*) sets the internal oscillator to a frequency of 32,768 Hz for accurate timekeeping. Trimmer capacitor *C2* permits slight adjustment of the oscillator's frequency to maximize precision.

Integrated circuit *IC2* forms a one-shot multivibrator that delivers a short pulse every five seconds or so to trigger the *IC1* date demand input so that the date will be automatically displayed. The network consisting of *R10* and *R11* divides the basic 4-volt dc line down to 2.5 volts as required by some elements within the clock chip.

Construction. The clock and its associated solar-cell array can be assembled on three separate pc boards, one for the solar-cell array, another for the basic clock circuit, and the third for the display. The solar-cell array can be assembled in a similar manner to that described for the basic array of Fig. 2 using only 11 solar cells and the series diode. Use the solar cell areas labelled with an X on Fig. 2 and do not install the NiCd cells on this board.

The etching and drilling and component-placement guides for the two clock boards are shown in Fig. 4. The liquid-crystal display mounts on a strip-type socket so that the small black wedge in the front of the display is positioned toward the small wedge on the conductor pattern of the board.

On the main board, install the resistors, capacitors, three jumper wires, and diode *D1*. Take care to observe the proper polarities of *D1* and *C3*. The cathode

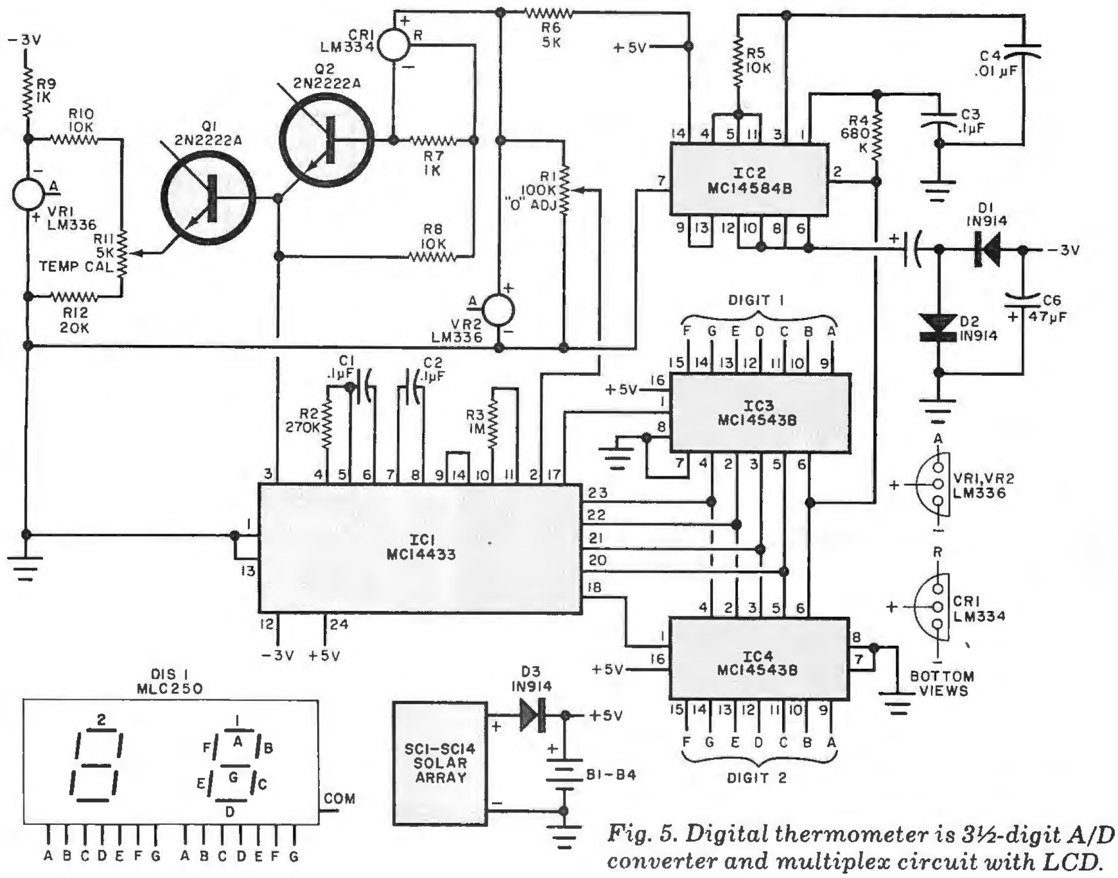


Fig. 5. Digital thermometer is 3½-digit A/D converter and multiplex circuit with LCD.

THERMOMETER PARTS LIST

B1 through B4—100-mAh nickel-cadmium cells (GE No. GCF250ST or similar)
C1,C2,C3—0.1-µF, 6-V capacitor
C4—0.01-µF, 6-V capacitor
C5,C6—47-µF, 6-V electrolytic capacitor
CR1—LM334 current regulator (National)
D1,D2,D3—1N914 diode
DIS1—MLC250 liquid crystal display (Motorola)
IC1—MC14433 3½-digit A/D converter (Motorola)
IC2—MC14584 hex Schmitt trigger (Motorola)
IC3, IC4—MC14543B BCD-to-7-segment latch/decode/drive (Motorola)
Q1,Q2—2N2222A transistor
R1—100,000-ohm, 10-turn trimmer potentiometer
R2—270,000-ohm, ¼-W resistor
R3—1-megohm, ¼-W resistor
R4—680,000-ohm, ¼-W resistor
R5—10,000-ohm, ¼-W resistor
R6—5000-ohm, 1% metal-film resistor
R7,R9—1000-ohm, 1% metal-film resistor
R8,R10—10,000-ohm, 1% metal-film resistor
R11—5000-ohm, 10-turn trimmer potentiometer
R12—20,000-ohm, 1% metal-film resistor
VR1,VR2—LM336 voltage regulator (National Semiconductor)
SC1 through SC14—SC-100 silicon solar cell (0.8" × 0.8", rated at 80 mA at 0.4 volt)
Misc.—Printed circuit boards (3); suitable enclosure (Radio Shack No. 270-285 or similar); sockets for IC's and LCD; machine hardware; hookup wire; solder; etc.

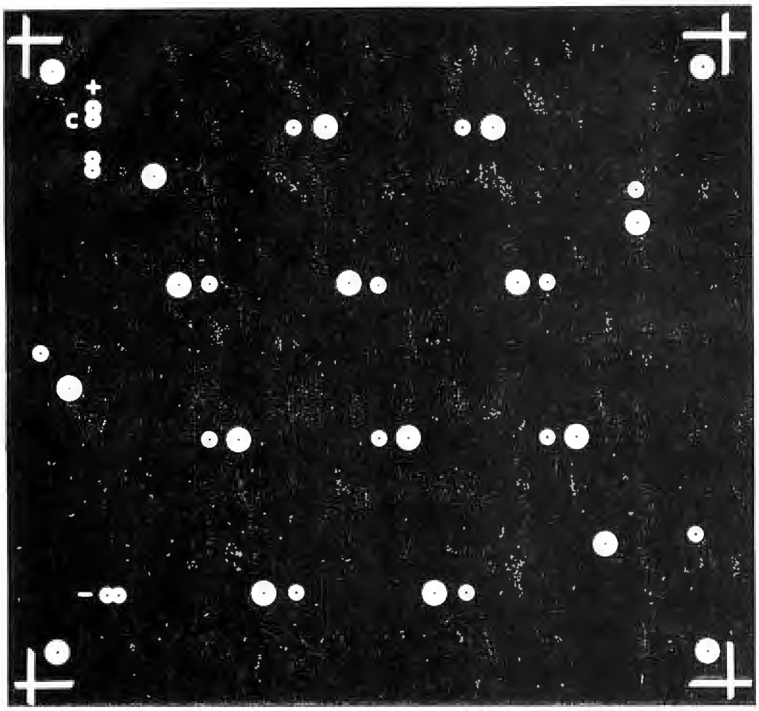
end of *D1* goes to the pad labelled C on the foil. Then install the crystal. Connect suitable insulated hookup wire leads for the four switches and the solar-cell array. Sockets are recommended for *IC1* and *IC2,* although they are not necessary. Install the two IC's last, taking care to orient them properly and observing the accepted procedures for handling MOS devices.

Note that the display and main boards have similar round copper pads near their edges. Insert a bare wire into each pad on the display board and solder into place. Then place the conductor side of the display board against the main board, the latter foil side down. Insert the two bare wires just installed in the display board through the mating holes in the main board. Firmly press the two boards together and solder the wires into place on the main board. (The row of pads on the display board should be slightly below the foil side of the main board.) Using thin wire and insulated tubing as necessary, interconnect the mating numbered pads between both printed circuit boards.

The three NiCd cells (*B1, B2, B3*) are installed on the main board using the solder reflow technique described above. Observe the polarities of each cell. Once installed, the cells can be initially charged using the solar-cell array or a dc power supply adjusted to deliver 100 mA for 1 hour and 20 minutes. In either case, the cells must be charged before attempting to calibrate and set the clock. Once the cells are charged, connect a frequency counter to the junction of the crystal and *R9* and the positive-voltage lead and then adjust trimmer capacitor *C2* for an indication of 32,768 Hz. If you do not have a frequency counter, use the timing intervals broadcast by WWV or CHU to adjust *C2.*

The clock can be mounted in any enclosure large enough to accommodate the circuit boards. Install the four switches on the rear panel of the enclosure. Mount the solar-cell array where its light-sensitive surface can be exposed to light through a cutout on the top of the enclosure.

Switch *S1* is used to set the minutes when the hours displays indicate 12 and the date when the hours indicate any figures other than 12. Switch *S2* is used for setting the hours. Switch *S3* is used for displaying the seconds and date on demand and, when held closed, allows the clock to display the seconds count-off. Releasing *S3* allows the clock to display the date for about 3 seconds. Switch *S4* is used to disconnect the timer from demand when setting the time. When the



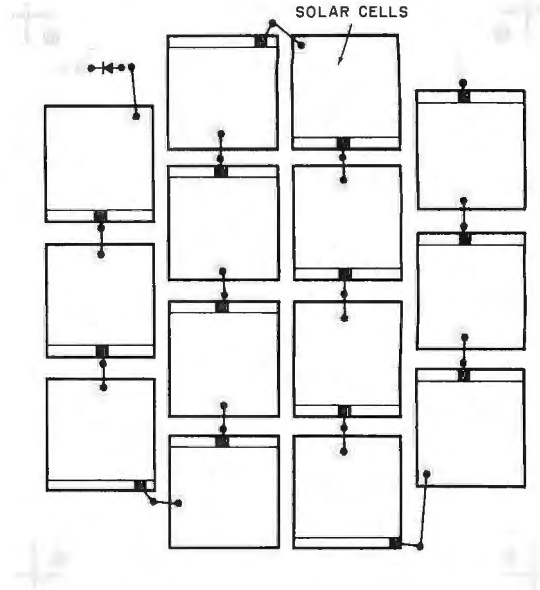


Fig. 6. Foil pattern and solar cell installation for the thermometer power supply.

clock is first turned on, the hours indicated are for AM, which must be kept in mind when setting the date.

To set the time, use *S2* to set the hours to any display but 12 and use *S1* to set the date. Operate *S3* to set the hours to 12 and *S1* to set the minutes. Use *S2* to set the hours and then depress *S3* to start timekeeping. Remember to keep *S4* depressed during the time setting and until *S3* is operated.

A Solar-Powered Thermometer. The liquid-crystal display thermometer shown schematically in Fig. 5 is essentially a digital voltmeter that has a temperature-to-voltage converter as its input. Two digits of °C or °F are displayed.

How It Works. Analog-to-digital converter integrated circuit *IC1* has multiplexed outputs, which require BCD-to-seven-segment latch/decoder/driver integrated circuits *IC3* and *IC4* to interface to the liquid-crystal display. Hex Schmitt-trigger *IC2* is designed as an oscillator that generates the clock signal required to drive the LCD and to simultaneously generate −3 volts dc (using *C5, D2, D1,* and *C6* as the RC timing elements) for the temperature converter and *IC1.*

Voltage dividers *VR1* and *VR2* provide a constant 2.5 volts to the temperature converter over varying battery-voltage levels. Current regulator *CR1* produces a constant current through *Q1,* whose base-emitter junction is used to sense the temperature. Temperature compensation for *CR1* (to provide stable current over a wide temperature range) is provided by *Q2, R7,* and *R8.* Note that 1% metal-film resistors are used in the converter to reduce drift over the temperature range of the system. Trimmer potentiometer *R1* is used to remove errors so that the system can produce accurate indications at 0° C and 32° F. The system is calibrated for accurate indications in either °C or °F by adjusting *R11.*

The thermometer uses CMOS IC's to keep its current drain to less than 3 mA. Since the system is powered from 200-mA NiCd cells, the thermometer can operate for about three days on fully charged cells. The solar cells used in this circuit can deliver about 80 mA in bright sunlight. About 5 hours and 20 minutes of bright sunlight or about 13 hours at a distance of 8" from a 100-watt incandescent lamp are required to fully recharge the NiCd cells.

Construction. Three circuit boards are required for the thermometer, as was the case with the clock/calendar. Shown in Fig. 6 are the etching and drilling and components-placement guides for the solar-cell array board, while Fig. 7 illustrates the guides for the main and display boards.

Install all passive components on the main circuit board, taking care to observe the proper polarities of *C5* and *C6.* Install *D1* and *D2,* again observing polarities, with the cathodes in each case going to the pads labelled C. Sockets are recommended for the IC's, but they are not necessary. Install *VR1, VR2* and *CR1,* observing the lead designations shown in Fig. 5. Install the IC's last, observing the proper orientations and using accepted procedures for handling MOS devices.

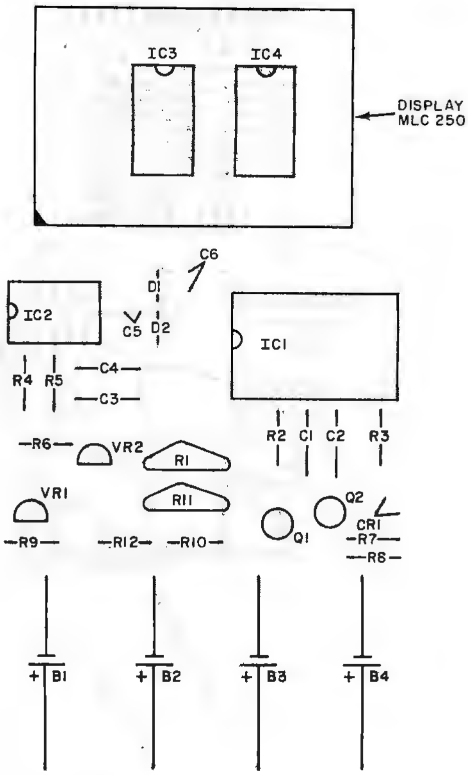
Transistor *Q2* can be installed directly on the board, while temperature-sensing transistor *Q1* can be mounted on the board, or it can be connected to the board via a twisted hookup wire pair if you wish to locate the sensor in a remote area.

Mount *IC3* and *IC4* on the display board as shown in Fig. 7. Install the LCD so that it straddles the two IC's, orienting it so that the small black wedge in the lower left aligns with the wedge on the board. Use a strip-type socket for the liquid crystal display.

Fasten together and interconnect the display and main board assemblies as described above for the clock/calendar.

Install the four NiCd cells as shown in Fig. 7, observing the proper polarities for the cells. Then charge the cells using the solar-cell array or a dc power supply adjusted to deliver 200 mA (about 1 hour and 20 minutes).

Calibration. Connect a voltmeter between pin 2 of *IC1* and circuit ground. Adjust *R1* for an indication of 0.46 volt for °C or 0.25 volt for °F. Use an accurate thermometer, positioned close to the main circuit board, to adjust *R11* so that both the thermometer and digital equivalent give the same indication. Allow the thermometer to stabilize be-



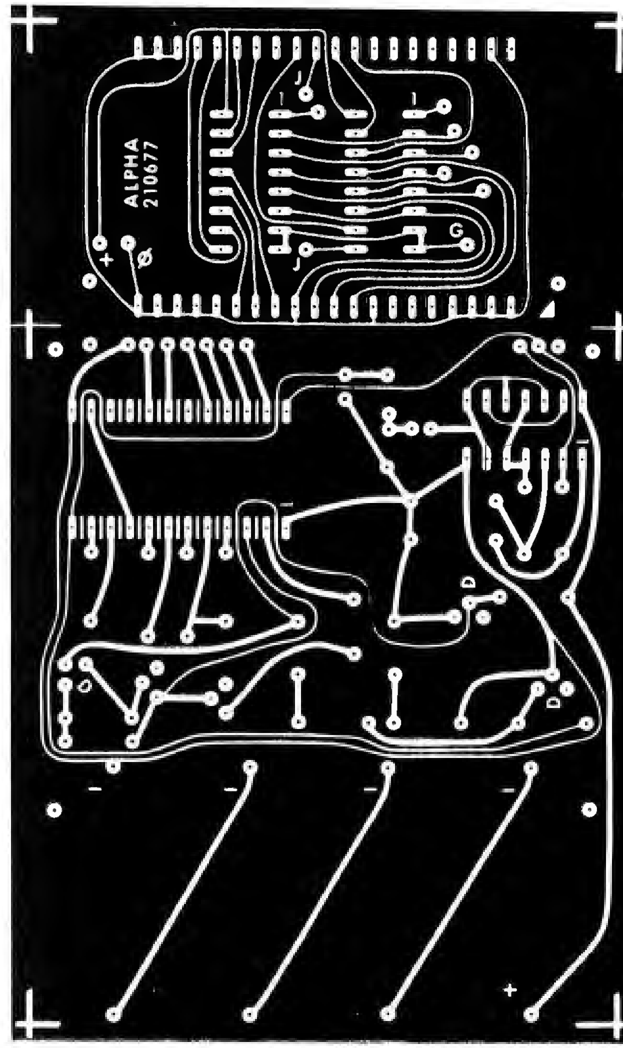


Fig. 7. Thermometer foil pattern is at right. Component placement above. Note NiCd cells.

fore performing this step. Note that potentiometer *R11* can be adjusted to obtain two "accurate"indications.

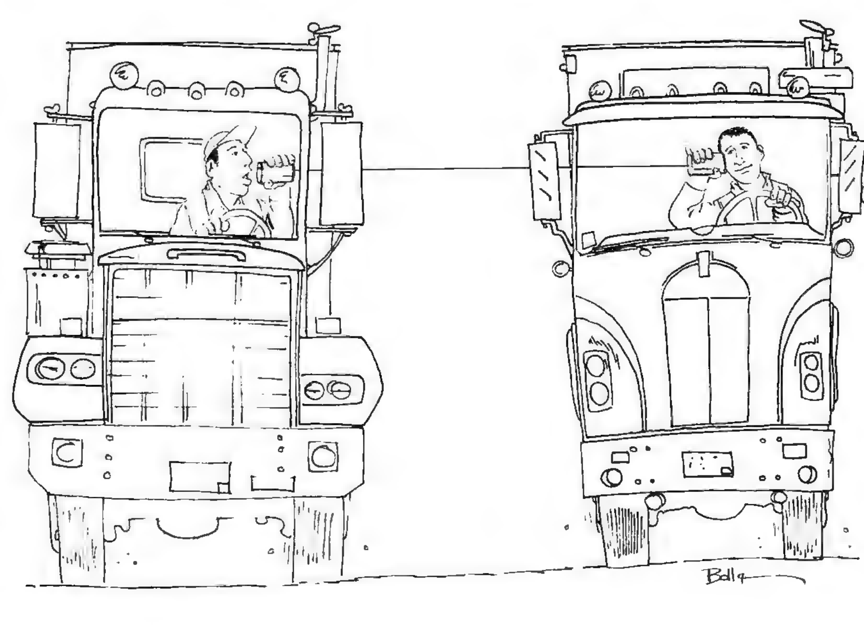
Once *R11* has been adjusted, warm up the case of *Q1* and observe the display. If the temperature indication goes up, *R11* is correctly adjusted. If the indicated temperature goes down as *Q1* is heated, change the adjustment of *R11* to the other "correct" position.

The solar-cell array can be mounted in a cutout in the upper surface of the enclosure selected to house the circuit. Alternatively, it can be located remotely and interconnected to the thermometer via a twisted-pair cable. The low temperature is determined by the liquid-crystal display and is approximately −5° C, while the upper limit is about 60° C.

Now you can let light charge the batteries of these and other projects to relieve you from dependence on electrical recharging or battery replacement. ◇

KIT AVAILABILITY

The following are available from Alpha Electronics, P.O. Box 1005, Merritt Island, FL 32952 (Tel.: 305-632-5534): No. SPS-1 solar power supply kit at $45 plus $2 for postage and handling; No. SCK-1 solar clock/calendar kit at $79.95 plus $3.50 postage and handling; No. STK-1 solar thermometer kit at $89.95 plus $3.50 postage and handling. Also available separately: No. SC-50 solar cells at $1.25 each; No. SC-100 solar cells at $2.00 each; 110-mAh NiCd cells at $3.00 each; 200-mAh NiCd cells at $3.80 each; No. 290777 pc board for solar power supply and clock power supply for $5.00; No. 280777 main and display pc boards for clock/calendar for $8.00; No. 230677 pc board for thermometer power supply for $5.00; No. 220677 main and display pc boards for thermometer for $8.00.



"Hey, big buddy. That's a big 10-4!"

HOW FM TUNERS WORK?

PART 1

Basic fundamentals of how they work— the front end, and the i-f section.

BY JULIAN HIRSCH

AS A SEPARATE component or as a part of a stereo receiver, the FM tuner is the principal source of stereo program material for many people. Frequency modulation (FM) broadcasting is noted for its wide frequency range, low distortion, and low noise; it is a true high-fidelity transmission medium. These qualities are characteristic of FM broadcasting, but they are not intrinsic to the basic system.

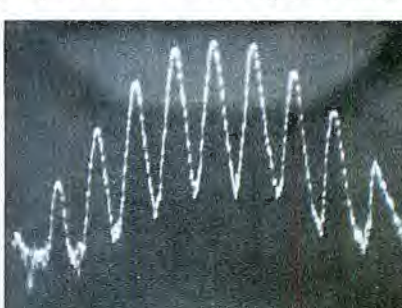
Frequency Modulation Basics. Commercial FM broadcasting achieves its special qualities because it is a wide-band system in which the maximum deviation from the channel center frequency is several times the highest audio modulating frequency. In fact, 100% modulation of an FM broadcast transmitter, whose audio bandwidth is nominally 15 kHz, corresponds to a frequency deviation of ±75 kHz. It might appear that a tuner bandwidth of 150 kHz would be quite sufficient for a 75-kHz deviation and that the 200-kHz spacing between channel assignments would give an ample safety margin for possible mistuning or for occasional overmodulation peaks (which are not supposed to occur). There are some other factors to consider, however.

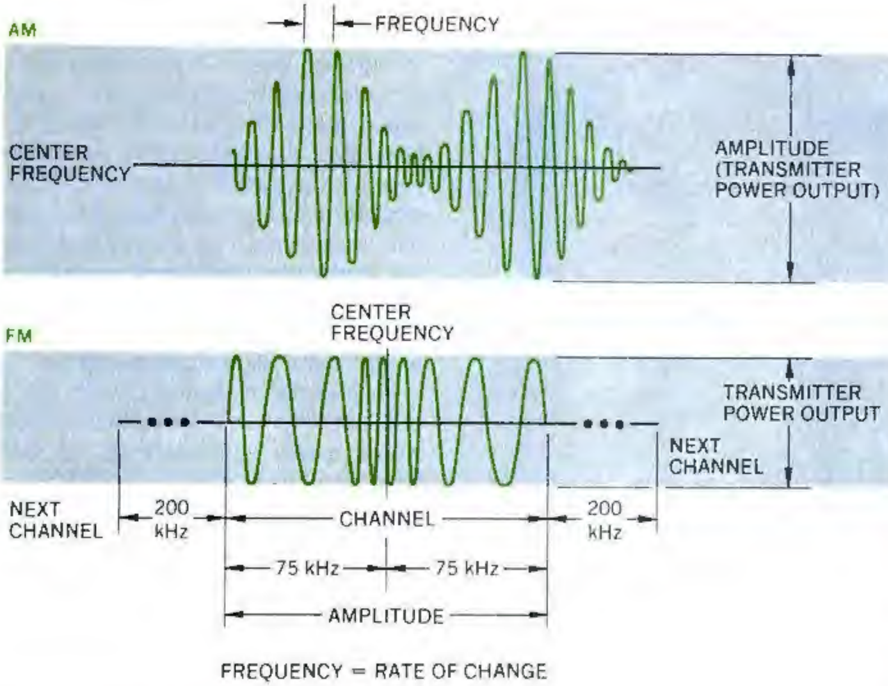
Unlike AM, where each modulating frequency creates a single pair of sidebands around the carrier and where the theoretical bandwidth of the signal is twice the highest modulating frequency, an FM signal in theory is composed of an infinite number of sidebands. The first-order sidebands, like those of an AM signal, are spaced from the carrier frequency by the amount of the modulating frequency. If the modulation index (the ratio of deviation to modulating frequency) is small, the spectrum of an FM signal looks exactly like that of an AM signal. (The phasing of the sidebands is different, but that does not appear in a spectrum analysis.)

As the modulation level is increased, additional pairs of sidebands appear above and below the FM carrier frequency. Each is spaced from its neighbors by the amount of the modulation frequency and for a time may decrease gradually in amplitude as one looks farther and farther from the carrier frequency. The situation becomes more complex as the deviation is increased, but it is plain that the spectrum width of an FM signal is not established as simply as it is for AM.

We used our audio spectrum analyzer to display the spectrum of an actual fre-

Fig. 1. A 100-MHz carrier frequency modulated by 2000 Hz.





Comparison of amplitude modulation with frequency modulation.

quency-modulated r-f signal. A standard FM signal generator, operating at about 100 MHz, was heterodyned down to about 30 kHz, which is within the range of our Hewlett-Packard Model 3580A spectrum analyzer. The frequency (horizontal) scale in Fig. 1 is 2000 Hz/division and the carrier is being modulated by a 2000-Hz audio signal, with a deviation of between 2000 and 3000 Hz. Note that the sidebands are spaced at 2000-Hz intervals and decrease in amplitude as one moves away from the carrier frequency. (The vertical, or amplitude, scale is 10 dB/division.)

If the spectrum had been for an AM signal, only the first pair of sidebands, those closest to the carrier, would have been visible and the total signal bandwidth would have been 4000 Hz. With FM, the bandwidth must be defined in terms of the allowable sideband amplitude. For example, if sidebands more than 20 dB below the carrier level are ignored, the signal bandwidth would be 8000 Hz. However, if components down to −50 dB are included, the bandwidth becomes 16,000 Hz. This is in spite of the fact that the maximum carrier deviation is less than 3000 Hz. Fortunately, the higher-order sidebands, under the conditions that exist in FM broadcasting, fall off quite rapidly so that interference between stations 200 kHz apart does not occur in practice. Any sidebands that extend into the adjacent channel are attenuated by the tuner's selectivity and have little or no effect on the quality of the received signal.

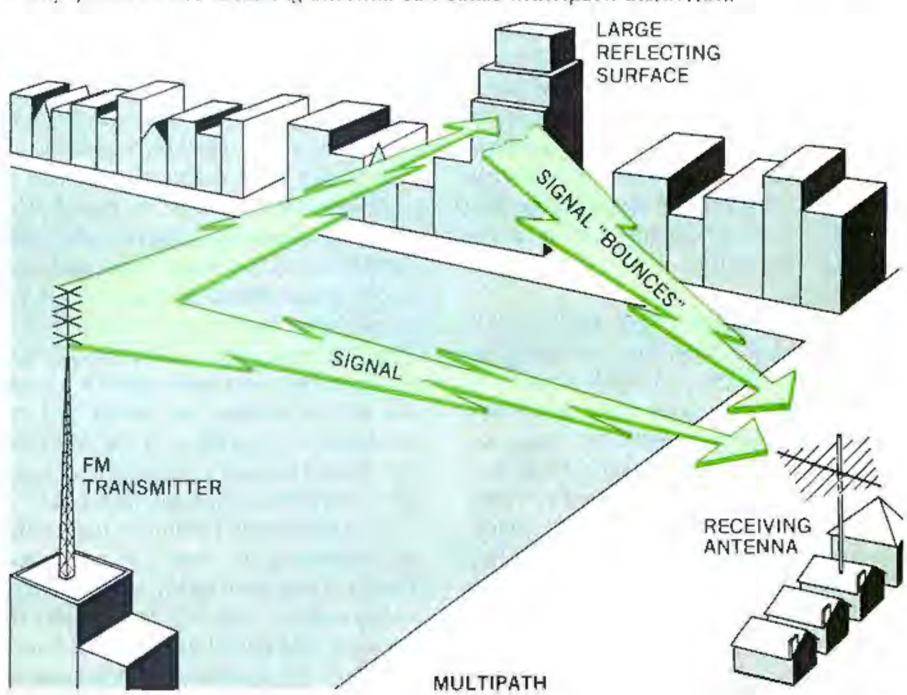
Inside an FM Tuner. In the FM tuner, broadcast transmissions between 88 and 108 MHz are converted to a 10.7-MHz intermediate frequency (i-f). The i-f amplifier provides most of the tuner's gain. It also has limiting to remove amplitude modulation from the received signal; and the tuner's detector (ratio detector or some form of discriminator) converts the frequency modulations to an audio signal. Almost all FM detectors are capable of responding in some degree to AM; hence, it is necessary to remove any AM from the signal.

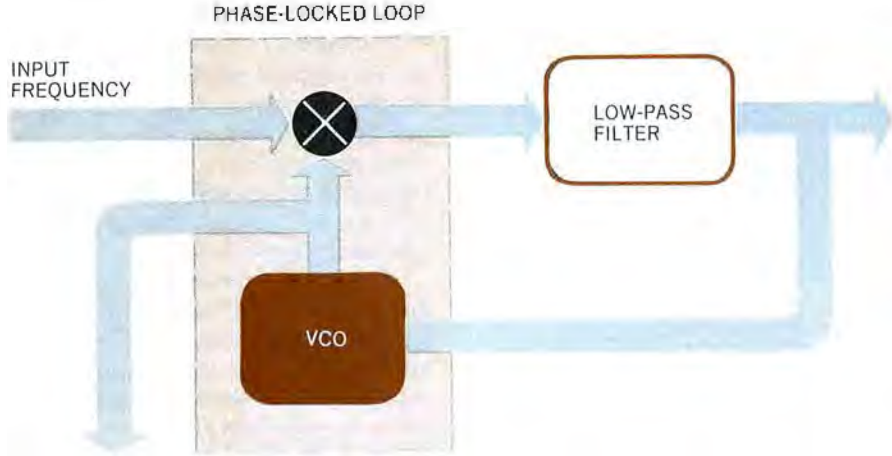
The source of the AM component in the FM signal is partly from external atmospheric or man-made interference and partly a component of the random noise that exists in every electrical circuit and is greatly amplified by the tuner's high-gain circuits. One of the most important sources of AM in an FM signal is "multipath" interference, caused by the arrival of the same transmission from different directions at slightly different times. This can cause a particularly unpleasant form of distortion if the tuner is able to respond to AM.

The amplified and limited FM signal is detected by a discriminator whose output waveform is essentially the same as that which modulated the transmitter. Most FM tuners use a ratio detector for this purpose. The ratio detector is inherently insensitive (but not totally immune) to AM, which simplifies the task of the limiters. The Foster-Seely discriminator, not often seen nowadays, is much less resistant to AM. Other types of detectors include the quadrature detector (available in a single IC chip together with the i-f amplifier and limiter) and the pulse counter detector. Each of these circuits has its advantages and disadvantages and all give good performance.

If the FM broadcast is monophonic, the output of the detector *is* the audio program, ready to be amplified and sent on to the amplifier that drives the speaker systems. If it is a stereo transmission, considerable additional processing is necessary to recover the two program channels. The detector output with a stereo signal is a composite signal that

Many paths to the receiving antenna can cause multipath distortion.





In typical phase-locked loop (PLL), an internal voltage-controlled oscillator is locked to a hormonic of the input frequency. In FM detector, the filter output is audio difference between input frequency and vco.

contains the basic 50-to-15,000-Hz audio band (which is in mono form and itself consists of the sum of the two channels, or L+R), a 19-kHz pilot carrier, and a double-sideband signal about a 38-kHz suppressed subcarrier. This signal contains the difference of the stereo channels (L−R).

After processing in the multiplex demodulator, the L + R and L − R signals are recovered and can be combined in a resistive matrix. The addition and subtraction of these signals results in separation of the left and right program channel signals. Each signal is then deemphasized by a simple RC network that has a 75-μs time constant that rolls off the response at a 6-dB/octave rate above 2100 Hz (complementing a similar boost at the transmitter) to yield a flat overall frequency response. This emphasis/deemphasis technique is used to reduce the noise in the received signal.

These fundamental processes occur in every FM tuner, although the circuit details may vary considerably. Now, let us examine an FM tuner from its antenna to its audio outputs and see how each function is performed and how they affect the specifications and listening quality of the tuner.

The "Front End". The "front end" is the portion of a tuner that translates the signals in the 88-to-108-MHz band to the 10.7-MHz i-f range. It normally has an r-f amplifier, a mixer or frequency converter, and a tunable local oscillator. A multi-section tuning capacitor resonates several LC circuits to the same frequency as the tuning is adjusted. The greater the number of tuned circuits in the front end, the better the tuner's ability to discriminate against out-of-band interference, such as image or i-f responses, as well as to resist overload from signals within the FM band itself.

Even though most tuners have only one r-f amplifier stage, it is possible to use more than one tuned circuit at the input and output of the amplifier, coupled in such a way as to improve the rejection of out-of-band frequencies. A few tuners have two r-f stages that can support a larger number of tuned circuits as well as provide additional gain at the signal frequency. Front-end gain, incidentally, is not a critical factor in determining the ultimate sensitivity of a tuner, since many tuners with a single r-f stage can approach the limits imposed by thermal noise in the 300-ohm impedance of the antenna system. Sensitivity, in the sense of noise-free reception of weak signals, is more a property of the i-f and limiter sections than of the front end.

You can judge the front-end selectivity of a tuner by counting the number of sections in the tuning capacitor. Manufacturers are quick to point out their use of multigang capacitors as evidence of the out-of-band rejection capability of their tuners. The practical minimum is three sections, one each for the r-f, mixer, and local-oscillator stages. Additional sections imply the use of more than one tuned circuit ahead of the mixer. One deluxe tuner has a seven-section capacitor, but most high quality models get along well with five sections. If the tuner has an AM section, be careful that the corresponding sections of the AM front end are not lumped in with the total number of advertised capacitor sections.

Early solid-state FM tuners used bipolar transistors in their r-f and mixer stages. They were easily overloaded by strong signals, resulting in spurious responses that gave transistorized tuners an unsavory reputation. Sometimes an antenna attenuator switch was provided to allow the level of the incoming signal to be reduced by 20 dB or so in strong-signal areas. The development of the field-effect transistor (FET) solved the overloading problem, with the result that modern tuners are less subject to spurious responses from overloading than were their vacuum-tube ancestors. Virtually every modern FM tuner uses a FET in its r-f stage, and most use another FET in the mixer stage as well.

Local-oscillator frequency drift was a problem with many vacuum-tube tuners, where it was aggravated by the heat from the tubes. Drift is really a characteristic of the passive components of the oscillator (principally the coil and capacitors in its frequency determining circuit), rather than of the tubes or transistors. Almost from the beginning, transistor oscillators were less plagued by drift than their tube counterparts, and automatic frequency control disappeared from the high-fidelity tuner scene for a few years. Recently, however, a few tuners and receivers have appeared with afc, although it is rarely needed to correct for drift. The reason for its inclusion in an inherently stable tuner is to minimize tuning errors. A variation on this system uses the tuning knob as a sensor. The tuning knob picks up hum or disturbs the balance of a capacitive bridge when it is touched. This disables the afc circuit. Once a station has been tuned in, even though it is not tuned in accurately, releasing the knob lets the afc take over final tuning. Even so, reasonable care is still necessary during tuning.

A few tuners are not tuned by physical variable capacitors. By using voltage-variable capacitance diodes called "Varactors," a number of tuned circuits can be tracked as they are tuned simultaneously by a single dc control voltage that usually comes from a potentiometer driven by a conventional tuning mechanism. Voltage-controlled tuning also simplifies pushbutton selection of preselected channels. Another feature of some voltage-tuned systems is the use of a dc voltmeter to replace the conventional dial scale, since the control voltage is uniquely related to the oscillator frequency.

In spite of its apparent convenience, voltage tuning has not achieved wide popularity. One reason for this is that it is much more difficult to build in the necessary stability (although it can be made almost as good as a mechanical tuning capacitor system). The voltage-tuned capacitors are silicon diodes operated with reverse bias, and they must be

properly matched for tracking of the various tuned circuits. Thermal drift of capacitance also can be a problem. The somewhat paradoxical result is that this tuning system, although potentially inexpensive, is limited to a few of the more expensive home audio products.

Synthesized tuners have been available for several years. The details of their synthesizer circuits, as well as the method of station selection, differ widely among the various models. In all of them, however, the stability and accuracy of the local oscillator are determined by a single quartz crystal oscillator. Most do not have conventional tuning dials (which are obviously not needed), but indicate the frequency on a digital numeric display. This is not to be confused with conventionally tuned tuners and receivers in which a frequency counter reads the local oscillator frequency, subtracts 10.7 MHz from it, and displays the tuned frequency on a digital display. In this case, the digital system serves only as a highly accurate and expensive substitute for a tuning dial. In most true synthesized receivers or tuners, channel selection is by means of punched plastic cards or a keyboard.

The I-f Section. After conversion to 10.7 MHz, the signal from the front end passes through a series of selective filters, usually employing ceramic elements. Isolation, impedance matching, and some gain are often provided by single-stage transistor amplifiers between the filter sections, with the bulk of the i-f gain coming from an IC amplifier following the filters.

The i-f filters are responsible for the tuner's selectivity (ability to reject other signals close in frequency to the desired channel) and for its distortion and stereo channel-separation characteristics. The "ideal" response of the i-f filter would be a flat top that is at least 150 kHz wide, with steep skirts to reject interference from stations on nearby channels. Another requirement, especially important for stereo reception, is that all signals within the passband of the filter be subject to the same time delay. In other words, the phase relationships between the various components of a stereo signal should not change as it passes through the i-f section.

Unfortunately, it is not possible to make a filter with ideal amplitude and phase characteristics, so that some sort of compromise is necessary. As we have seen, the FM sidebands may extend, at low levels, beyond the nominal 150-kHz channel width. To accommodate them, the usual practice is to make the response of the filter slightly wider than 150 kHz and to design the filter for good phase characteristics. The latter is generally obtained by sacrificing some of the ideal steep-skirted, flat-topped shape of the response curve.

Almost universally, FM i-f filters use ceramic elements whose piezoelectric properties allow them to function as mechanical resonators with electrical inputs and outputs. Two or three pairs of filters are usually used to provide better skirt selectivity. A few years ago, quartz crystal filters were used in the same way, but it was found that equivalent results could be obtained from less expensive ceramic elements. In a few high-priced tuners, multipole LC filters are used, either to replace ceramic types or in addition to them in separate "wide-band" i-f amplifiers. They allow the designer to tailor the phase and amplitude response to suit his goals. If properly designed and used, they can deliver the highest performance possible at present, in terms of low distortion and good channel separation.

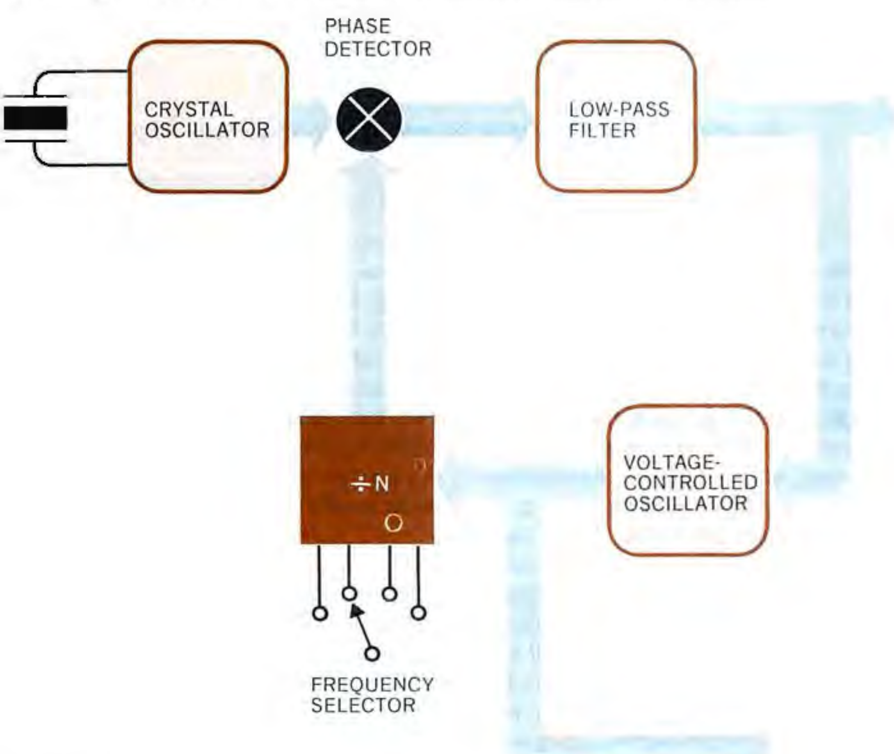
All modern i-f filters, whether of LC, quartz, or ceramic construction, share the advantage of being permanently adjusted and aligned. Until five or six years ago, i-f selectivity was usually obtained with a series of double-tuned transformers that could not match the performance of a good fixed filter and required periodic realignment.

The necessary i-f gain can be obtained from one or more IC stages, although a few tuners still employ several stages that use discrete transistors. A boon to the designer of low-to-moderate-priced tuners, is the availability of specialized FM IC's that include many functions on a single chip.

Sometimes, it is possible to see the impact of a specific piece of improved hardware on tuner performance. A good example is the phase-locked-loop (PLL) multiplex demodulator IC that is widely used in tuners of all prices. The PLL eliminates most of the critical components and adjustments that were formerly necessary to set up the stereo separation of a tuner. As a result, channel separation is dramatically improved in today's tuners and receivers over those of only two or three years ago, and it does not degrade with time. The early user of the PLL could justifiably claim that it was responsible for his product's exceptional stereo performance, but today almost everyone uses similar devices.

The concluding part of this article next month will discuss stereomodulation and demodulation and include a buying guide listing of FM tuners including specifications and features. ◇

The voltage-controlled oscillator can be locked into any multiple of the crystal frequency. Divide-by-n block simulates tuning dial.



TO THE ELECTRONIC RACES!

An exciting LED game to test the abilities of two players.

BY JAMES BARBARELLO

AGILITY, strategy, competition and luck—the classic ingredients of a race—are found in the electronic game, "To The Races." Designed for two players, the project has a race track formed from two rows of nine LED's each. Readily available CMOS digital and 556 dual timer IC's, and standard LED's are used in the game's circuitry. Four "C" cells form a power source. Total construction cost is about $25.

At the outset of a race, a RESET switch is closed and each contestant's START LED glows. Then four control LED's (one pair at each playing position) start blinking. Below each control LED, a pushbutton switch is mounted, one labelled SAFE BET and the other A CHANCE. The LED above the SAFE BET switch blinks about once every 3 seconds, and the LED above the A CHANCE LED about three times that rate. These LED's remain on for approximately ¼ second.

If a contestant closes one of the two pushbutton switches while the corresponding LED is glowing, he advances one position. This is indicated by the darkening of the LED at the position previously occupied and the turning on of the adjacent LED. The faster flash rate of the LED above the A CHANCE switch permits much quicker progression around the track, but a penalty is associated with the switch's use. If it is depressed while the corresponding LED is dark, that player's circuitry is reset and he is sent back to the starting position.

No such penalty is associated with the SAFE BET switch. Therefore, you must choose between the two pushbuttons wisely. You might want to take a chance initially and pull ahead. Once you have established an early lead, you can play it safe and use only the SAFE BET switch. The first contestant to reach the FINISH position is the winner. At that point, his opponent's pushbuttons are disabled, so no further moves can be made.

About the Circuit. The schematic diagram of To The Races is shown in Fig. 1. One half of *IC1*, a 556 dual timer, operates in the astable mode and provides clock pulses for control LED's *LED3* and *LED4*, which correspond to the SAFE BET switches (*S3* and *S4*). Clock signals for *LED1* and *LED2*, which

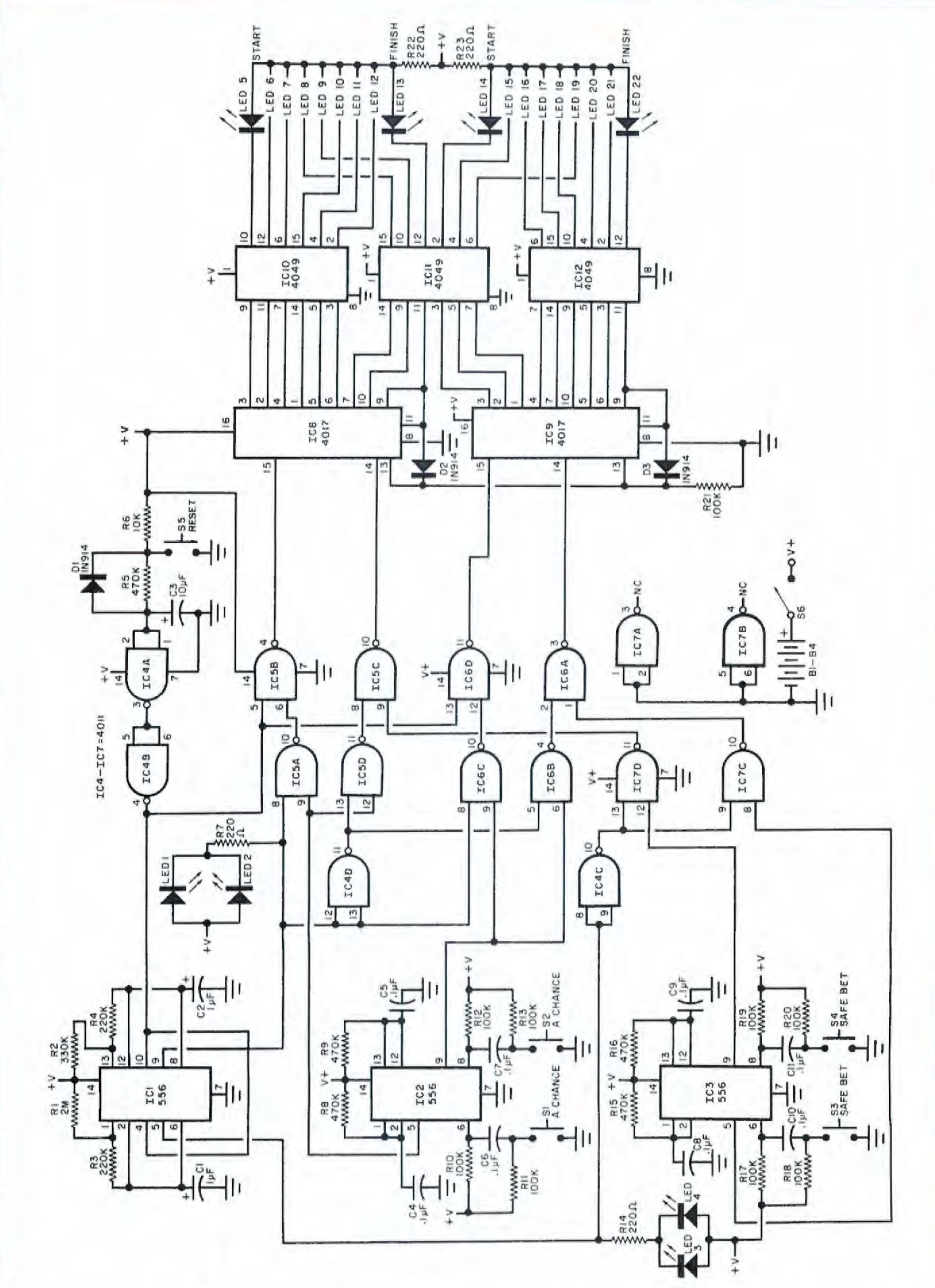


Fig. 1. Schematic of "To The Races" shows how circuit works. For Parts List, see next page.

PARTS LIST

B1 through B4—1½-V "C" cell
C1, C2—1-µF, 25-V electrolytic capacitor
C3—10-µF, 25-V electrolytic capacitor
C4 through C11—0.1-µF disc ceramic capacitor
D1 through D3—1N914 silicon diode
IC1 through IC3—556 dual timer
IC4 through IC7—4011 quad 2-input NAND gate
IC8, IC9—4017 decade counter/decoder
IC10 through IC12—4049 hex inverting buffer/converter
LED1 through LED22—20-mA red LED (TIL-32, or equivalent)
The following are ¼-watt, 10% tolerance carbon resistors:
R1—2 megohms
R2—330,000 ohms
R3,R4—220,000 ohms
R5,R8,R9,R15,R16—470,000 ohms
R6—10,000 ohms
R7,R14,R22,R23—220 ohms
R10 through R13, R17 through R21—100,000 ohms
S1 through S5—Normally open, momentary-contact pushbutton switch
S6—Spst toggle switch
Misc.—Battery holder, 14- and 16-pin DIP IC sockets, LED holders (NSL001) or rubber grommets, suitable enclosure, printed circuit or perforated board, hookup wire, solder, etc.
Note: The enclosure used, Model DMC-1, is available from Continental Specialties Corp., 44 Kendall Street, Box 1942, New Haven, CT 06509.

correspond to A CHANCE switches *S1* and *S2*, are generated by the other half of *IC1*, also operating in the astable mode. These clock signals are inverted by *IC4D* and *IC4C*, respectively. Contact debouncing for the A CHANCE and SAFE BET switches is performed by the four monostable multivibrators comprising dual timers *IC2* and *IC3*, respectively.

NAND gates *IC4A* and *IC4B* form a noninverting buffer on the RESET line. When RESET switch *S5* is closed, *C3* rapidly discharges through *D1*, causing *IC1*, *IC8*, and *IC9* to reset.
Opening *S5* allows *C3* to charge through *R5* and *R6*. When the voltage across the capacitor reaches the logic one threshold (one half the 6-volt supply voltage), the output of *IC4B* goes high, enabling the previously reset IC's. Capacitor charging time is about two seconds. This delay allows one contestant to reset the game and prepare for play so that neither contestant gains an initial advantage.

If *S1* (A CHANCE) is closed while pin 9 of *IC1* is low and *LED1* and *LED2* are glowing, a pulse is transmitted through NAND gates *IC5C* and *IC5D* to pin 14, the CLOCK input of *IC8*, a 4017 CMOS decade counter/decoder. If pin 9 of *IC1* is high and *LED1* and *LED2* dark when

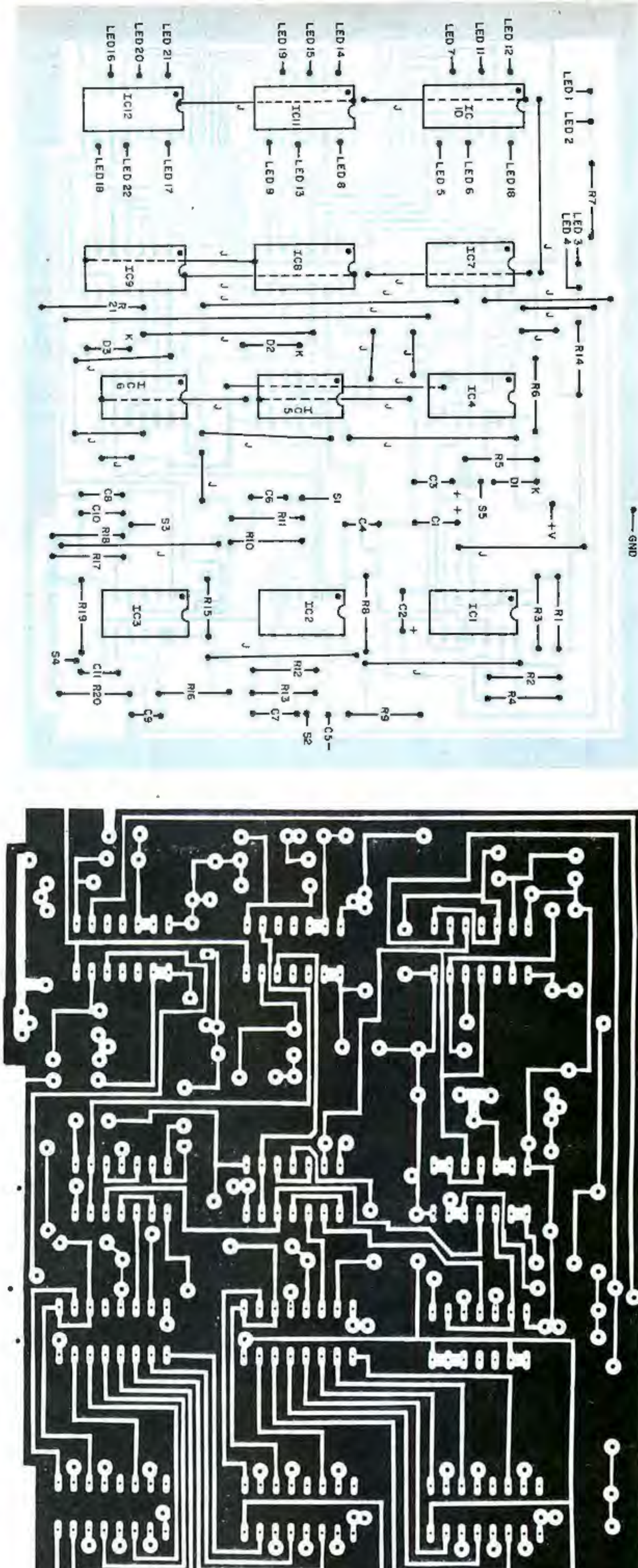


Fig. 2. Pc board etching and drilling and component (top) guides.

S1 is closed, the output of *IC5A* goes high and resets counter *IC8*. Closing *S4* (SAFE BET) when pin 5 of *IC1* is high and *LED3* and *LED4* are dark has no effect on pin 15 (the RESET input) of counter *IC8*. This functional description applies equally to *IC9, S2,* and *S3*, the other contestant's decade counter/decoder and switches, respectively.

As each counter receives clock pulses, it counts upward and the successive decimal outputs go high. The inverting buffers (*IC10A* through *IC12F*) connected to the counter outputs change state in turn, so that the counter outputs that are high drive the buffer outputs low. When buffer outputs are low, they sink current for the race track LED's (*LED5* through *LED22*) connected to them. Current limiting for the LED's is performed by *R22* and *R23*. Only one limiting resistor per row is required because only one LED per row is on at any time. When pin 9 of either counter goes high and FINISH *LED13* or *LED22* glows, the OR gate formed by *D2, D3,* and *R21* causes the ENABLE input (pin 13) of both counters to go high. This freezes the counters and prevents further triggering of either one.

Construction. Printed circuit (guides shown in Fig. 2) perforated board, or Wire Wrap techniques can be employed to duplicate the circuit. The use of IC sockets is recommended. Be sure to observe the polarities of all IC's, diodes, and electrolytic capacitors, and to exercise care when handling the CMOS devices. The author's prototype was housed in a Continental Specialties Corporation Model DMC-1 case. However, any enclosure large enough to house the components and battery power supply can be used. Drill and label the front panel of the enclosure using the photograph of the prototype as a guide. Use LED holders or rubber grommets to retain the LED's in place.

Use. Close power switch *S6* and RESET switch *S5* in that order. Both START LED's and the four control LED's will glow. Two seconds later, the control LED's will start to blink, signalling that play can begin. The "on" time of the LED's and switch conditioning one-shots have been chosen to be close to the average person's reaction time. Therefore, both contestants will have to watch the blinking LED's and anticipate when they will glow. After a few initial games, you will become adept at play and ready for serious competiton when you go "To The Races." ◇

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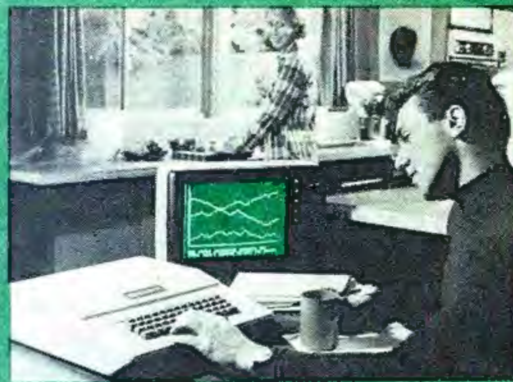


APPLE II Computer System

Basic Guide to Computer Buying

DID YOU know that there are more than 120 companies now manufacturing home computer equipment? And 60 of them actually make computers themselves. Moreover, most provide a bevy of options, while some offer a range of radically different models in their product lines. It's no wonder, then, that buying a home computer system is such a bewildering experience for so many people. So let's establish some sense of order for the buyer to follow in this chaotic, new marketplace.

STEP I

The first step in buying a computer for personal use is to decide whether: (a) you want to build one from a kit; or (b) you want to purchase a wired, checked-out system.

If you choose approach (a), you can save about $200 to $300 on machines that sell for about $900 in wired form. That's a fat savings, but you substitute assembly time and face some possible frustrations and delays if the final product doesn't work properly the first time you use it. You do, though, gain a better idea of how the unit goes together (useful for further modifications and servicing) and have the pleasure of "rolling your own." It's not all that difficult, either. Assembling a microcomputer is easier than building an audio preamplifier.

Whatever your decision, you will have eliminated some confusion since some manufacturers offer *only* wired models, and others offer *only* kits. Many makers offer both versions, of course. Interestingly, there are slightly more wired models available today than there are kit models; but this does not necessarily reflect the number of units sold.

STEP II

The next decisions you face are: "What kind of home computing do I want to do now and in the near future?" and "Will I want a basic system that can be expanded indefinitely, or one which is pretty complete and ready to plug in and use as soon as I get it?" Your answers to these questions will help you evaluate the many types of systems available.

If, for example, you want to experiment with and learn about computers and their inner workings, with little concern for large-scale data-processing, you can get a *tutorial system* for as little as $100. Examples are National Semiconductor's SC/MP, RCA's COSMAC 1802 (as used in PE's "Elf" computer), MOS Technology's KIM-1, Paia's 8700, IMSAI's 8048, and E&L's MMD-1. Such systems usually have calculator-type keyboards for input of programs written in the computer's own "machine code," in either hexadecimal (base-16) or octal (base-8) numbers. Some systems have batteries of switches instead. Readout is most often on seven-segment LED's.

Despite their similarities, such systems differ widely in their capabilities. The "Elf" has graphics capability, IMSAI's 8048 has on-board relays to control household devices, and the E&L MMD-1 has a "breadboard" area for experimenting with computer circuits. Some systems even provide for future expansion and the use of high-level programming languages such as limited BASIC; examples include KIM-1 and SC/MP.

These all-on-one-board computers can easily be confused with the "single-board computers" sold for engineering development use, such as the Motorola "Exorcisor" and Intel "SBC." These are less complete, lacking keyboards and readouts.

Chances are, that you'll learn more about computers with the tutorial type than types discussed later, though tutorial systems are less convenient to use and expanding them into full-blown computers can eliminate their price advantages. Since they usually come without enclosures, they're not easily blended into your living room decor, either; but they do give you a great start in hobby computing with only a small investment.

Programming in machine-language, as you must with most tutorial computers, teaches you a great deal about how the computer works; but it's a slow, demanding process. If you prefer to use a high-level language such as BASIC for writing and running useful and/or entertaining programs, you'll probably want a computer in the next major category: *mainframes*.

These may be likened to separate stereo components—a main power amplifier (the mainframe itself) a separate preamplifier with controls (the terminal) and so on. Most of the full-blown home computers sold today are of this type. It offers the greatest equipment-selection flexibility: BASIC language, internal memory expansion, provisions for plugging in a video terminal, printer, video display module, floppy disk, etc. This is where the home computer industry first started, with the introduction of the MITS "Altair." Here one also finds a myriad of different brands, including Imsai, Heath, Cromemco, The Digital Group, Southwest Technical Corp. and Polymorphic, among many others.

Mainframes are usually built around a *motherboard*, with slots to hold perhaps a dozen or more additional circuit boards. Most commonly, these boards will hold additional memory, allowing the use of longer programs and the handling of more data, or extra "*I/O*" (Input/Out-

put) ports for connection of such peripherals as printers and terminals. But you'll also find boards to display the computer's output alphanumerically or graphically on a video screen, to control external devices, to communicate with other computers by telephone, to accept vocal input or give "spoken" output, to play music, to measure frequencies or temperature, to tell time, and to read or write PROM's (memories which don't "forget" their programs when the computer is turned off).

Some mainframes have *front panels* chock full of lights and switches, while others are essentially devoid of them except for "power" and "reset." The switches allow one to program the computer directly—a laborious process, but better than nothing if you don't have a separate terminal. They're an aid in troubleshooting, though. With switchless front-panel machines you must have an external terminal. Otherwise the computer cannot be used. Usually, this host of front-panel switches raises the price of the mainframe. A few manufacturers, however, charge more for "*turnkey*" models without front-panel operation.

The next type is the all-in-one computer, such as Processor Technology's "Sol," Apple Computer's "Apple II," Radio Shack's "TRS-80," Compucolor's "8001," Ohio's "Challenger," and Commodore's "PET." The PET is a true all-in-one, coming with a built-in 9-inch black-and-white video monitor, keyboard and audio tape cassette machine for program storage. Compucolor's $2750 computer terminal features a 19" color video display, full video terminal, 8-track "Floppy Tape" cartridge and a keyboard in a separate housing. The other machines mentioned have built-in keyboards but require separate TV monitors. Therefore, some of these models may be compared to the hi-fi industry's stereo FM/AM receivers, while others could be likened to integrated amplifiers or control amplifiers.

What you gain with a computer of this type is neatness and physical simplicity. Naturally, you trade off some choice of video monitor or keyboard and may wind up with less internal space for the addition of more memory or other module boards. Also, except for "Sol" and "Challenger," the computers in this group are not available as kits.

STEP III

Program support is vital. Without programs, you can't run a computer. And writing your own programs, even if you already know how, can be time consuming. Most computer manufacturers offer a number of programs for their computers. Moreover, other sources make available such "software."

Programs written for other computers can be adapted for yours if both computers are built around the same microprocessor unit (MPU). So program availability is partially a function of your MPU's popularity. The 8080 is the most popular MPU, used by about 21 manufacturers, at last count. This is followed by the 6502 and Z-80, which have garnered about 12 companies each. (The Z-80 can also use most 8080 software, but not vice versa.) The 6800 follows with 7 companies, while the 1802 has 5 computer makers using it. The SC/MP is used by two companies. Others, such as the LSI-11, are only supported by one company in the home computer field.

But numbers alone don't tell the whole story. It makes a difference which companies support each chip, as well as how many companies do. Models with Intel's 8080 are offered by MITS, Processor Technology, Heath, IMSAI, Polymorphic, Parasitic, HAL, Compucolor, and Vector Graphic, to name just a few. The Z-80 (from Zilog, a group of designers who broke off from Intel)has Radio Shack, Cromemco, and Technical Design Labs, among others. Motorola 6800 users include Southwest Technical Products Corp (SWTPC), MITS and M&R. The MOS Technology 6502 and its closely-related 6503 are incorporated into computers from Commodore (MOS Technology's parent company), Ohio Scientific, Microcomputer Associates, and Apple, with more joining them. RCA and Netronics are among the companies using RCA's 1802 in kits.

The LSI-11, used only by Heath, is made by Digital Equipment Corp., the leader in the commercial minicomputer industry. It employs the same programs as DEC's PDP-11, which means there is a great deal of very useful software already available for it. The SC/MP, too, is supported by a major manufacturer—National Semiconductor Corp.—which makes the chip and also provides great support for it.

Mainframe producers do not always supply wholly satisfactory documentation, but such information can be expanded by seeking out other sources such as the chip manufacturer and a variety of available texts.

There are some MPU's not noted because there aren't enough end-users to make computers based on them wise choices for most hobbyists. It's helpful to have plenty of users like yourself who can get together at a computer club and exchange operating, modifying, and servicing ideas, as well as trading of programs and discussions about the latest hardware and software. However, there are many new models that will eventually have many users.

At this time, there are more 8080-based computers in use among hobbyists than any other type; probably more than half of the total. (A Homebrew Computer Club. 1976 survey of 100 members found 53 using the 8080, for example.) As a consequence, the 8080 has hung on for some time now as the MPU employed by many computer manufacturers. Other types, however, are indeed making inroads. The 6800-based machines appear to be an easy second in numbers already in the field. However, don't sell the other MPU's short. As the market expands, more software will become available for them.

Aside from program support, the choice of MPU makes surprisingly little practical difference to the average hobbyist. Choosing a computer for its MPU is like shopping for a car on the basis of its engine—usually, you first find the car you're interested in and then, perhaps, give some consideration to the engine. But since some readers are intent on weighing the various MPU's, let's briefly explore them:

The computing "power" of an MPU chip is a function of the number of its internal registers, its speed, and the size of its instruction set. More registers and more instructions mean you can shorten your programs by doing directly, in one step, operations which might take several steps otherwise.

Speed is not very important in most home computing applications. The difference between an average-speed MPU and an extremely fast one will rarely be obvious unless you're either running very long, involved programs or using the computer to control a device whose status changes rapidly.

Some MPU's require as many as three different supply voltages; others require only one. The number of power supplies needed will influence the cost of the computer and the time required to build it from a kit.

STEP IV

Another factor that may or may not be important to you is the computer's *bus structure*. This is the system of leads that carry signals and power to various parts of the computer. The first powerful hobbyist computer, the Altair 8800, uses a 100-pin bus with its 8080 MPU. Manufacturers of add-on equipment who moved into the field naturally made

module boards that mated with what was then the only hobby-computer bus. Computer mainframe makers who subsequently entered the hobbyist market with 8080-based machines also used the "Altair bus," calling it the "S-100" bus. Even more module boards were made for it. Thus, today, there is a wider range of module boards (for memory expansion, vocal interfaces, etc.) that can plug into this bus than into any other.

Bus pinouts have to match, of course, so the 100-pin plug-ins cannot be used on a computer with a different bus structure, such as SWTP's 6800 model, Radio Shack's new entry, Heath's recently introduced computers, or others that utilize different bus systems. Many of these companies have their own lines of module boards and peripherals to match their mainframes. Aside from the 100-pin bus, only SWTP's 6800 computer has drawn the attention of add-on manufacturers thus far. Other buses will probably attract multi-manufacturer support in time.

STEP V

The keypads or switches of tutorial or front-panel computers are useful for machine-language programs. But if you want to use a high-level language such as BASIC (which is much easier to learn), you'll need both a means of loading the program that lets the computer understand BASIC and a typewriter-style keyboard to address that program once it's in.

The program loaded will stay in the computer unless the computer is turned off or there is a blackout. More and more hobbyists, however, are paying an extra buck to have BASIC in ROM so that it will not be eradicated in the event power is shut down. This is sometimes called "firmware" as opposed to "software," which is what tape would be called.

There are different levels of BASIC, each usurping some of your computer's memory (which costs about $40 or so per kilobyte). The more memory it requires, the greater the instruction and data-handling power it provides. Tops is 12k, followed by 8k, 4k, and 2k (called "Tiny BASIC"). To this you should add at least 2k more memory for your own programming use.

Most mainframe manufacturers have a form of BASIC available. Some are better than others. Also, the language differs slightly from one manufacturer to the next. As a result, if you run someone else's program based on another brand's BASIC on your computer, you'll have to do some editing. This sounds easy, but it could be very frustrating as you search for the correct command. For example, on one form of BASIC, the word "CLEAR" is used to wipe out whatever programs are in memory. In another BASIC version, the word is "NEW." This is another reason why many computer hobbyists band together in choosing a particular model. It makes it easier to trade software.

STEP VI

There is a *potpourri* of other factors to throw into your computer buying evaluations. For example, you will probably run out of memory in time—no one ever seems to have enough memory. So look ahead if you've gone past the tutorial-type computers, to the day you will require more memory. Check how much can be added inside the computer (usually by plugging more memory boards into the motherboard) and, if that's limited, whether more memory can be added externally.

Given some practical computer operating experience, you'll surely want some means of *mass storage* for storing programs outside the computer. This protects you from having your programs wiped out by a blackout or a blown fuse, and allows you to write and store more programs than the computer could possibly hold at once.

Here you have a choice of a paper tape reader/perforator, an audio cassette interface, or a floppy disk. There are many different cassette storage methods, each, of course, incompatible with the other. For example, there is the "Kansas City Standard" that's not really a standard but used by many hobbyists. Then there's the "Tarbell" type, which is much faster than the KC method. And a few manufacturers have their own special audio tape cassette systems for recording data. Here, too, it's best to check your friends or local computer stores to see which one is best to use in your area for program exchange purposes. Floppy disks are the most useful, but also the most expensive. Even if you own one you might also want a cassette or paper tape system for program interchange. Most hobbyists don't move up to "floppies" till their systems are quite far along.

For high-level languages, you also need a keyboard (separate or on a terminal), and either CRT or printer output. CRT terminals are quieter, faster, and don't use up paper. (But printers give you a permanent record.) Check CRT's for number of lines of text on screen—the more the merrier. Cursor control and page mode help you edit, too. For both printers and CRT's, check the number of characters per line (again, more is better). If you need both capital and lower-case letters, get a terminal whose "character set" includes 96, not just 64 different ASCII characters. (Don't confuse this with the number of characters per line.)

STEP VII

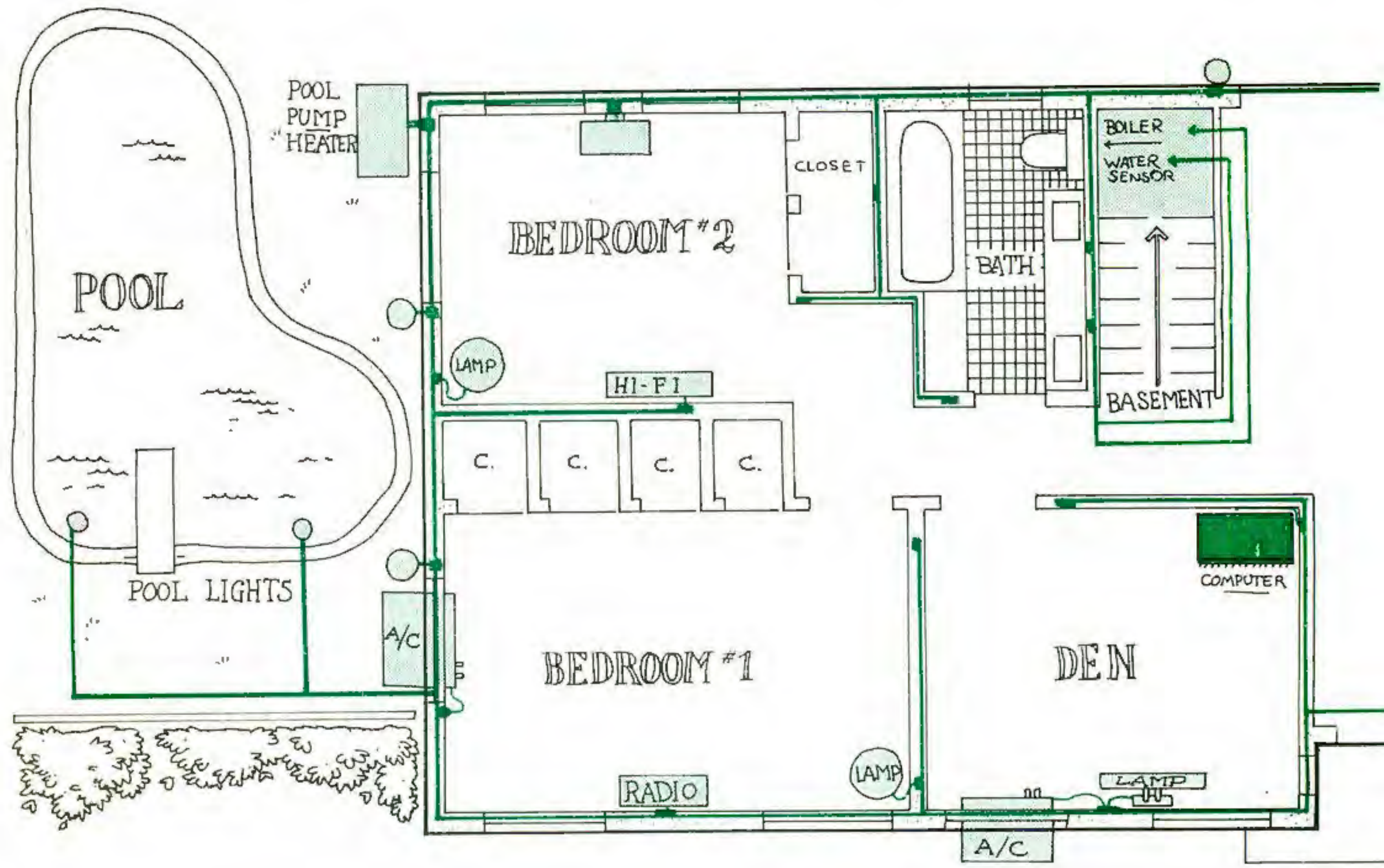
If you have an opportunity to view computer equipment you're considering buying, there are a few other things to look for. For example, check the keyboard to see if you like the way it performs; listen to the noise level the microcomputer produces (some fans can be very noisy); check a video monitor for reading ease (both size and resolution). If it's a kit, check the assembly instructions to see if they're clearly written and satisfactorily illustrated.

We won't belabor cost here, because that's a judgement *you'll* have to make. It's your pocketbook. But do weigh in all the factors so that you get the most value for your money. There's no set weighting factor for each consideration simply because every person probably places more value on one factor than another—whether it's appearance, the ready availability of program tapes, service, what most of the local computer hobbyists own or plan to buy, and so on.

STEP VIII

Lastly, the manufacturer's reputation should be considered. Has the company been in business for many years? This is a new field so many will not have been, but a company that has been around for awhile evokes a feeling of confidence. Is there a local service center for warranty or out-of-warranty work? It's always nice to be able to talk to someone eyeball-to-eyeball if necessary. Besides, who wants to pack and ship a heavy, bulky product across the country if it can be avoided? Can someone at the factory be reached by telephone in the event of a problem? And if so, are they courteous and helpful? Is the company's general image a good one, as judged from its advertising and promotional literature, and from talking to computer store personnel and computer hobbyists? Balance your judgements with care, though. Some companies don't offer especially good communications with customers, but make up for it in very good product value.

One final word—get a copy of our latest annual, the 1978 ELECTRONIC EXPERIMENTER'S HANDBOOK. It includes a complete home computer product directory for mainframes, peripherals and module boards. ◇



Using Existing House Wiring

BY DAN SOKOL, GARY MUHONEN, AND JOEL MILLER

SOME HOBBYISTS with their own computers at home, use them to play sophisticated games. Others use them for "number crunching." Still others use them simply to learn more about working with microcomputers. Where many computer owners fail to make use of their machines is in the control of electrical appliances in their homes. With the recent introduction of several "controller" boards, in which the computer can activate a power switch, such as a relay or SCR, under program control, the computer's role in the home will undoubtedly change. However, there still remains the frustrating task of wiring the output lines of the computer to the controlled appliances in other rooms.

The Intelligent Remote Controller described here makes room-to-room control wiring a relatively simple matter. With a controller board plugged into any Altair 8800/S-100 bus system, a special ac adapter is connected to the controller board and plugged into the ac line. Commands given by the computer program are sent via the controller to the ac adapter, which impresses the digital waveform on the ac line at the wall receptacle. Hence, instead of running cable all through your house, you simply take advantage of the already existing house wiring to route signals to various remote appliances.

Special dual-channel remotes, which can be connected to any wall outlet in the premises for both power and reception of the digital control signals, are used for the actual power control. Each remote has two conventional, separately controlled, ac sockets that can accommodate any electrical appliance rated at 500 watts or less. Of course, the output circuits can be modified to handle higher-power appliances.

The remotes (up to 64 with this system) constantly monitor the ac line for commands intended for them. When a command for a particular remote is detected, it controls one or both of the appliances plugged into it, turning on or off the power. The remote then "reports" back to the controller on the status of the selected device.

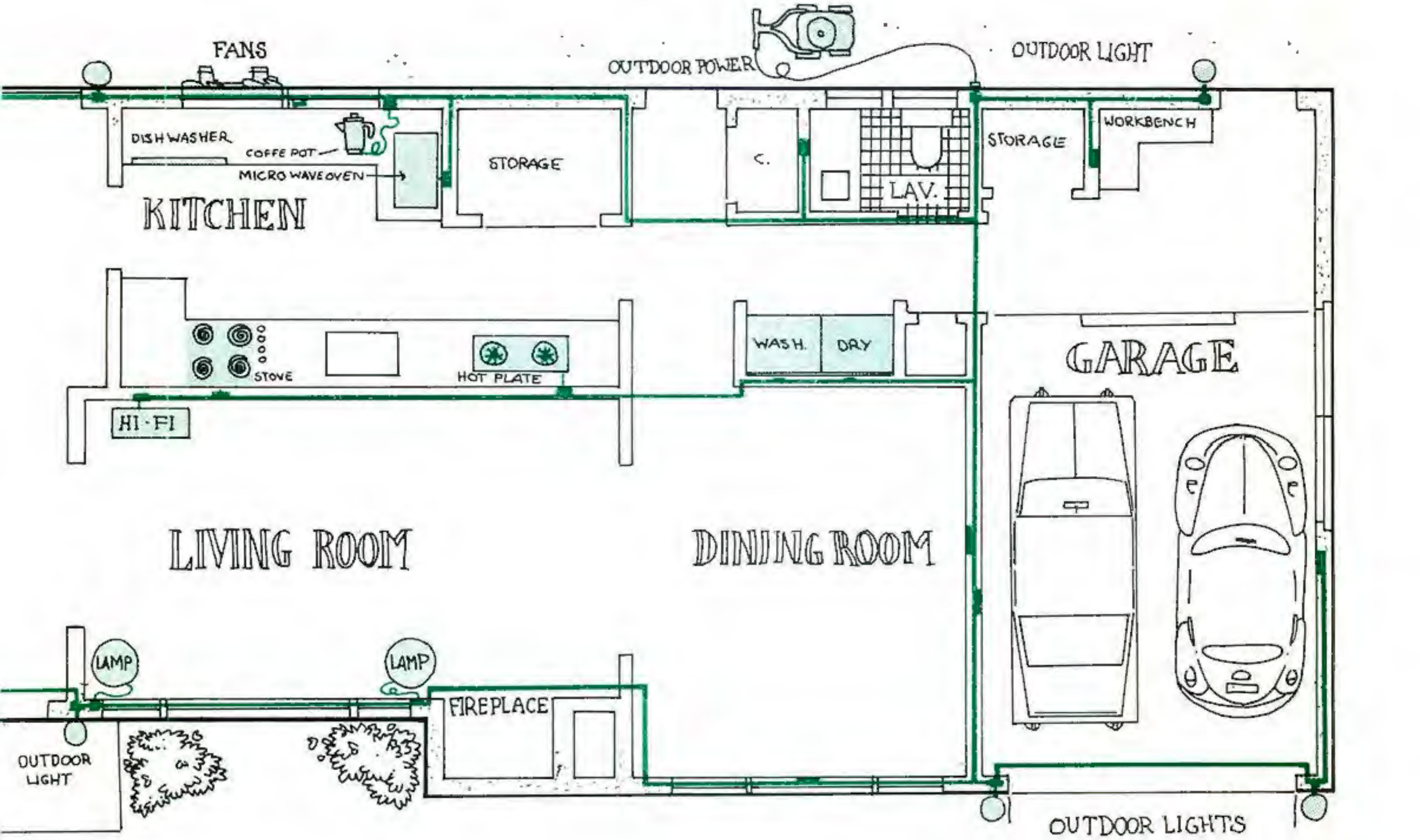
In this first article, we cover the controller circuit (Fig. 1). There are two major sections in this device—the controller itself and a self-calibration circuit that is used for setting up the remotes.

The power supply for the controller board is shown in Fig. 2. It is typical of most computer bus boards.

About the Circuit. The controller occupies three I/O ports. These ports are assigned by board jumpers, with the input and output sharing the same address and the status port being the input port minus one.

In this bidirectional system, the user can "poll" each remote to determine its status. Two ports are used for both writing data to and receiving data from the remotes. Since decoding circuitry is built into each remote, up to 64 remotes can be controlled by the system.

The filter/amplifier/limiter circuit that is shown in Fig. 3 accepts an input from the ac adapter, passes only that portion of the signal above 20 kHz, and conditions it for use by the following data-



for Computer Remote Control
PART I

recovery PLL (phase-locked loop). Although the amplifier's gain is set at 5, its output is diode-clipped at 0.7 volt to prevent the PLL from being overdriven and eliminate false triggering. Transistor *Q4* acts as a switch that shuts down the amplifier during calibration and during the transmission of data.

The data-recovery and clock-generator circuit consisting of *IC4*, *IC6*, and *IC8* recovers the transmitted data and generates the transmit frequency. When data is present, the locked output from pin 8 of the PLL outputs the data, which is sent to the UART receiver.

To generate the transmit frequency, the output of the free-running vco in the PLL is buffered by *IC6* and used as the transmit frequency by AND'ing it with the UART data before the data is sent to the ac line. In addition, this frequency is divided by 16 by *IC8* to generate the clock for the UART and the reference clock for the self-calibration circuit.

During the receive cycle, UART *IC18* is clocked by the frequency of the vco so that the vco in the receiver locks onto

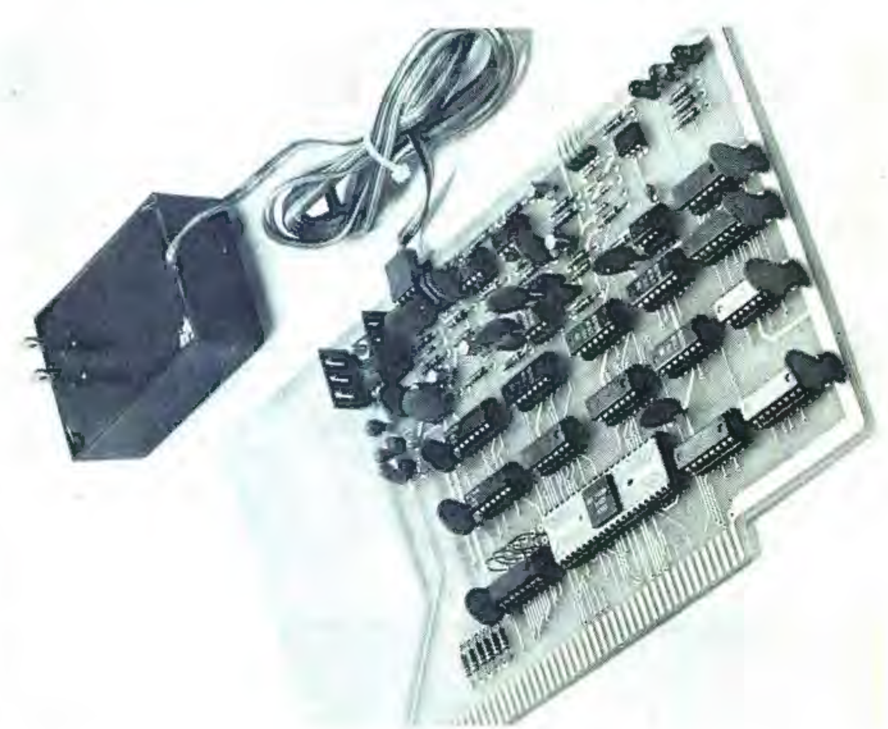


Photo of prototype controller board with adapter plug into ac line.

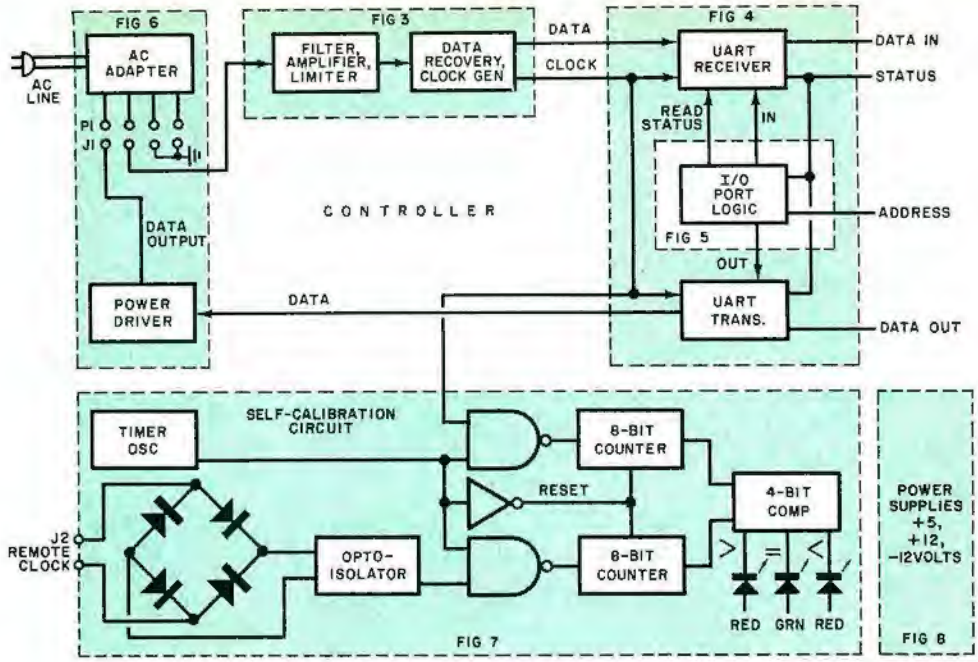


Fig. 1. Overall logic of controller that also includes self-calibration circuit for remote oscillator alignment. Sections of the controller are referred to by figure numbers in which complete schematics are given.

PARTS LIST

C1 through C5, C10 through C14, C17, C18, C19, C25, C26—0.1-µF disc capacitor
C6—0.1-µF disc capacitor
C7—0.0056-µF disc capacitor
C8—0.39-µF disc capacitor
C9—0.01-µF capacitor
C15, C16—0.001-µ F disc capacitor
C20, C21—15-µF, 15-V tantalum capacitor
C22, C23—10-µF, 25-V tantalum capacitor
C24—1-µF, 35-V tantalum capacitor
C27—.1-µF capacitor
D1 through D7—1N4148 diode
*IC1, IC2—NE535V op amp
IC3—MCT-2 optoisolator
IC4—567 phase-locked loop
IC5—555 timer
IC6, IC13—74LS04 hex inverter
IC7, IC12—74LS32 quad 2-input OR gate
IC8, IC9, IC10, IC15, IC16—74LS93 4-bit counter
IC11—74LS85 4-bit magnitude comparator
IC14—74LS132 quad 2-input NAND Schmitt trigger
IC17—8131 6-bit comparator
IC18—TR1802 UART
IC19, IC20—74367 tri-state hex buffer
J1, J2—4-pin right-angle jack (Molex)
LED1, LED3—Discrete red LED
LED2—Discrete green light-emitting diode.
Q1, Q2, Q4—2N2907 transistor
Q3, Q5—2N2222 transistor
The following resistors are ¼-W, 10% tolerance:
R1 through R7, R9, R19—2200 ohms
R8, R12, R13, R18, R29—1000 ohms
R10—390 ohms
R11—10 ohms
R14, R15, R22 through R25, R34—3300 ohms
R16—3900 ohms
R17—15,000 ohms
R20, R21—10,000 ohms
R26, R30, R31, R32—100 ohms
R27—4700 ohms
R28—100,000 ohms
R33—27,000 ohms
RV1, RV2—V33MA1A voltage regulator (GE)
VR1—7805 5-volt regulator IC
VR2—79L12 12-volt regulator IC
VR3—78L12 12-volt regulator IC
Misc.—Printed circuit board; sockets for IC's; heat sink and mounting hardware for VR1; interface adapter No. ACD-1; wire; etc.
Note: The following is available from Mountain Hardware, Inc., P.O. Box 1133, Ben Lomond, CA 95005 (Tel.: 408-336-2495): complete controller kit, including ac interface module for $149.
*IC's are identified by letter "U" in parts placement guide in Fig. 8.

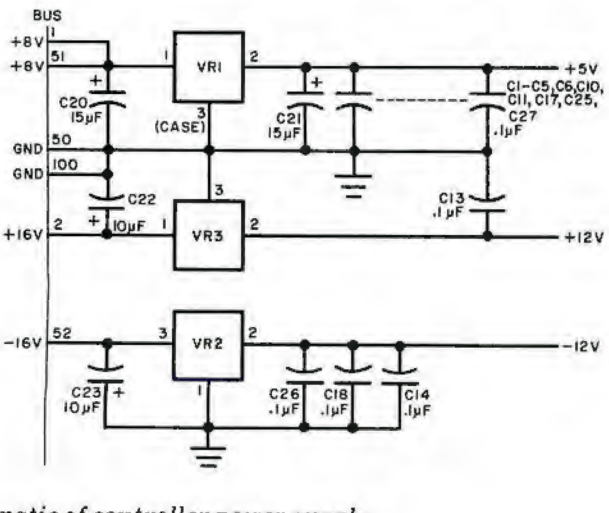


Fig. 2. Schematic of controller power supply.

the frequency of the vco in the transmitter and provides a stable source of the same frequency to the UART. This eliminates the need for expensive crystal oscillators and divider circuits.

The heart of the controller is the UART, shown schematically in Fig. 4. This circuit receives, transmits, and formats data that is sent between the computer and controller. The controller and each remote have their own UART's. Since the UART outputs are tri-state, both the status and the data information can be AND'ed to the same bus.

When power is first applied, the UART is reset by the POC (power-on clear) signal on bus connector 99 after passing

through inverter *IC13*. The UART can be programmed to deal with 5-, 6-, 7-, or 8-bit words, can be set for odd or even or no parity, or the number of stop bits can be set to 1, 1½, or 2. In this circuit, the UART is set for eight data bits, odd parity, and two stop bits.

The transmitter portion of the UART removes the parallel data from the bus and transmits it serially to the power driver circuit. When transmitting a signal, TEOC (transmit end of character) from *IC18*, pin 24's signal is inverted and used to disable amplifier *Q5* in Fig. 3 to stabilize the vco.

The receiver portion of the UART accepts serial data from the PLL, converts it into parallel data, and checks for possible errors. The parallel output of the UART receiver is passed to the bus via tri-state buffers *IC19* and *IC20*.

The receiver section constantly checks its serial input line for a start bit, defined as a mark-to-space transition. When it receives this signal, it waits for a period of time equal to a half-bit period. Then it checks to see if the space is still there to determine if it is a valid start bit. If the start bit is not valid, the UART resumes searching. If the bit is valid, the next 10 bits are clocked into an internal shift register. The start and parity bits are removed before transferring the 8-bit data word to the output holding register. Finally, the UART sets a status flag when readout data is available and when an error is detected.

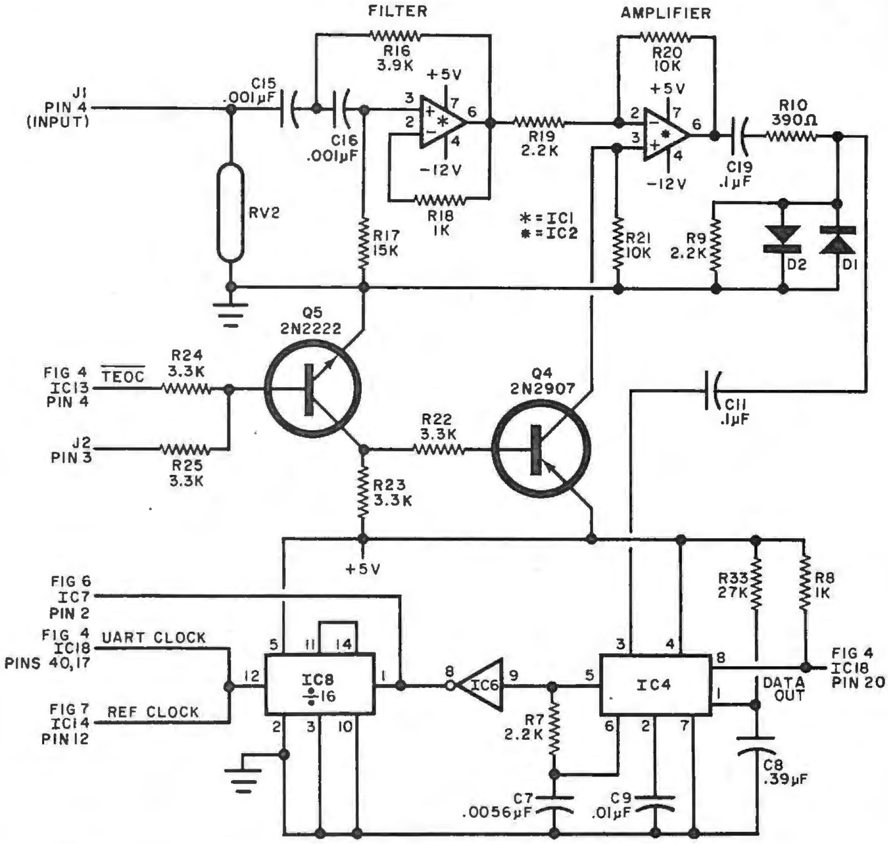


Fig. 3. Filter, amplifier, limiter, and data and clock recovery.

The three error flags are: receive parity error, receive framing error, and receive overrun error. A receive parity error bit of 1 indicates that the data word in the holding register was received with a parity error. If the receive framing error bit is a 1, the word in the register did not have the correct number of bits. If the receive overrun error is a 1, the new word has overwritten the word previously stored in the register before the old word was read out, indicating that this word has been lost.

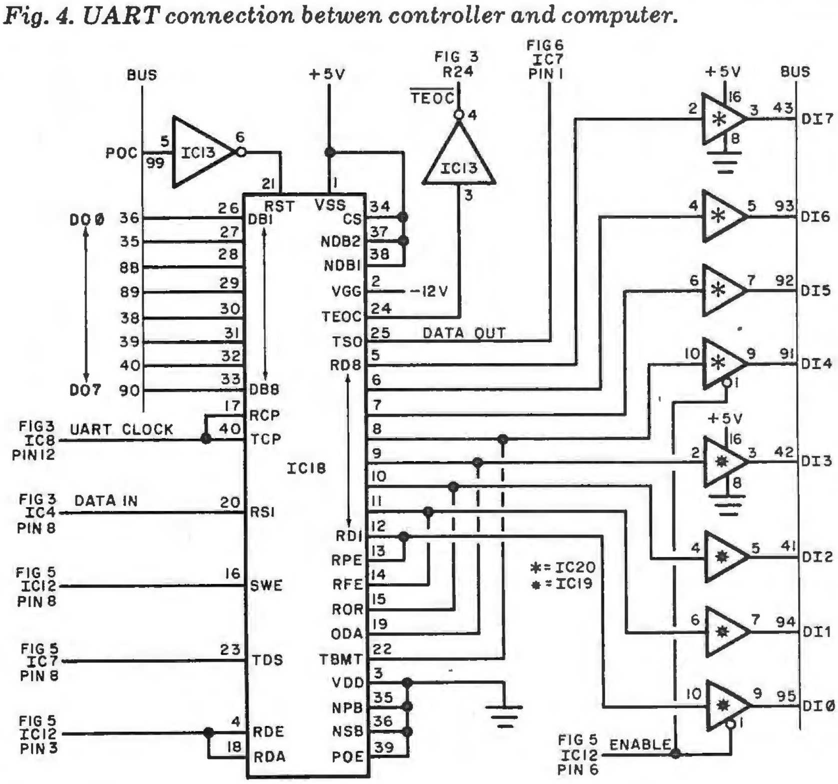
Two other status bits are available: output data available (ODA) and transmit buffer empty (TBE). When ODA is a 1, data is available at the receiver's holding register. When TBE is a 0, the transmitter is busy.

The I/O port decoder shown in Fig. 5 determines if the computer is communicating with the controller and prepares the controller for transmitting or receiving data. The output of this circuit causes the controller to place data on or read data from the computer bus.

The circuit acknowledges three commands internal to the controller: read status, read the UART receiver's holding register into register A of the computer, and transfer register A data into the UART buffer and begin the transmit cycle. These internal commands are related to system software commands IN and OUT (the assembly language mnemonics for communicating between the computer and controller). Integrated circuit *IC17* and its associated logic determine the I/O port selection, while the remaining integrated circuits in Fig. 5 decode the command from the computer controller.

The power driver, shown schematically in Fig. 6, provides sufficient drive for

Fig. 4. UART connection betwen controller and computer.



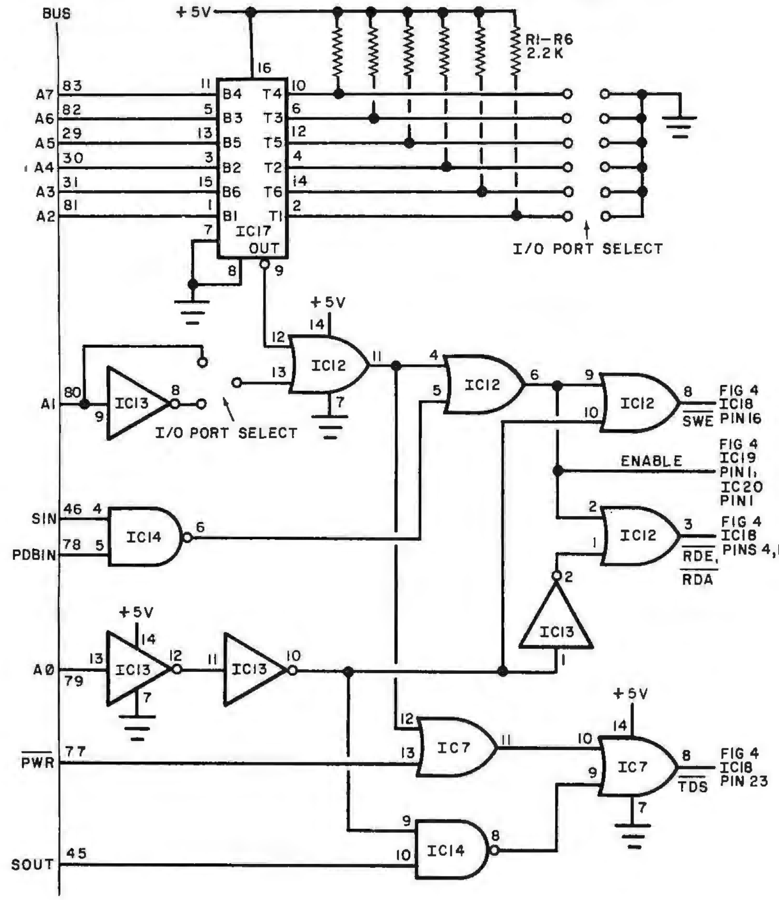


Fig. 5. The I/O port selection is made by choosing the jumper arrangement for the selected port.

the signal to ensure adequate reception at the remote receiver. The driver AND's the transmit frequency with the UART transmitter's serial output (TSO). The circuit then converts the TTL-level input signal into ±15-volt levels. The resulting signal is entered into the ac line via the ac interface adapter, which consists of a package that contains three capacitors and a tuned transformer that is resonant at 50 kHz. The adapter is connected to the controller via a four-conductor cable to connector *J1*.

For the system to function properly, the free-running vco frequencies must be within 4% of each other. If they are not, receiver overrun errors result in incorrect data. The self-calibration circuit shown in Fig. 7 is used to adjust the remote vco. The vco in the controller is not adjustable; it is used as the "reference" for the system. The self-calibration circuit visually indicates whether the remote vco is running faster, slower, or at the same rate as the controller's vco. This circuit also eliminates the need for a relatively expensive frequency counter to check both oscillator frequencies.

The UART clock on the controller board is used as the reference frequency, and the UART clock from the remote is connected to the controller via *J2*. The remote is coupled through optical isolator *IC3* to keep any line voltage from appearing on the controller board.

The signal from *IC3* is shaped and gated by *IC14* and then passed to counter *IC15*. Free-running oscillator *IC5* provides control for *IC14* and generates the reset pulse for the counters. This oscillator is set for a 1% duty cycle and provides a "window" to enable the reference clock (and its equivalent from the remote) in two eight-bit counters (*IC9, IC10, IC15,* and *IC16*). The counters are arranged as two eight-bit counter chains, and the long period of 99% of the *IC5* output is the window that allows the counter to operate, while the short 1% period pulse resets both chains. The four most significant bits from each counter are compared in four-bit comparator *IC11*.

The outputs of the comparator are inverted and buffered by portions of *IC6* and are used to drive three LED's. On the "less than" or "greater than" outputs, red-colored *LED1* and *LED3* glow. When the output is "equals," green-colored *LED2* glows.

During calibration (described in Part II), a cable is connected between the controller and remote. It disables the analog sections and provides a signal path between the two boards. The analog section must be disabled to remove jitter from the vco's.

As the vco control potentiometer on the remote vco is adjusted, the period of time that the green LED glows becomes longer and longer, indicating that the two vco's are running at the same frequen-

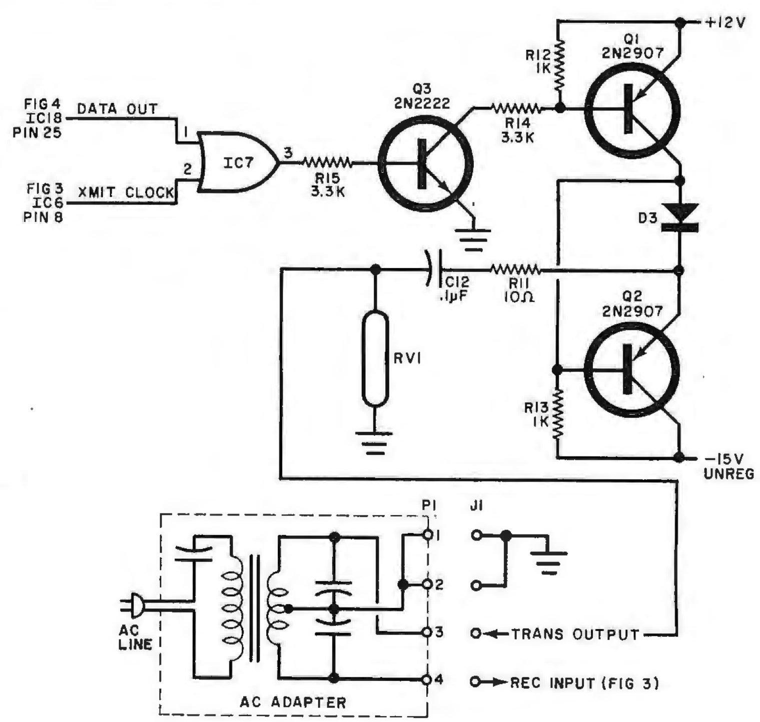


Fig. 6. Power driver accepts UART data and clock and delivers high-level signal to ac adapter.

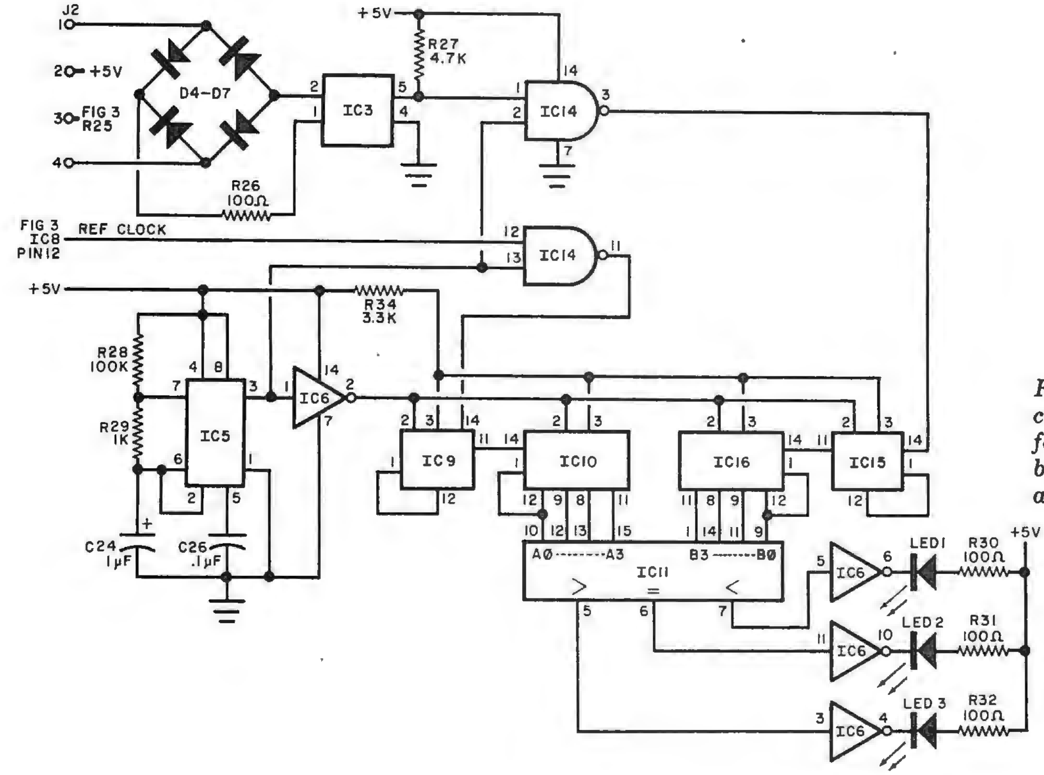
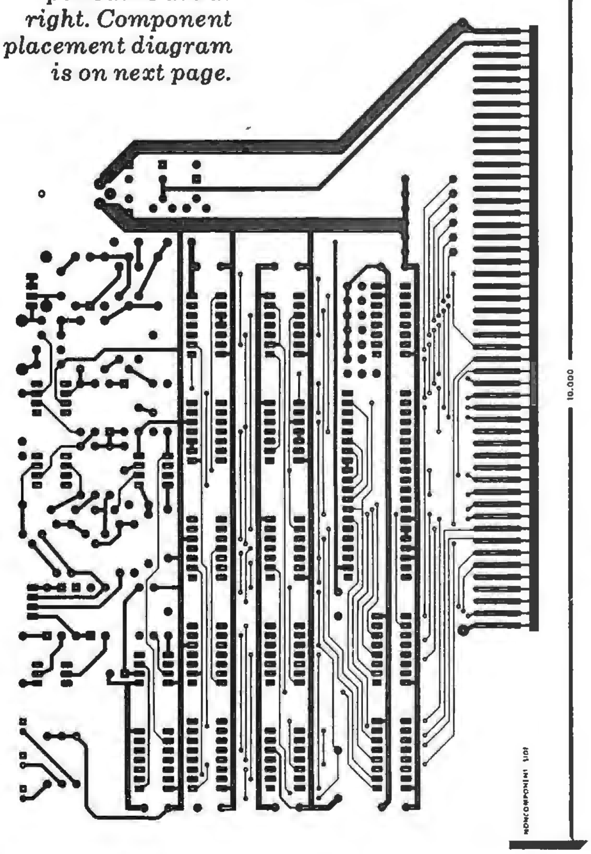
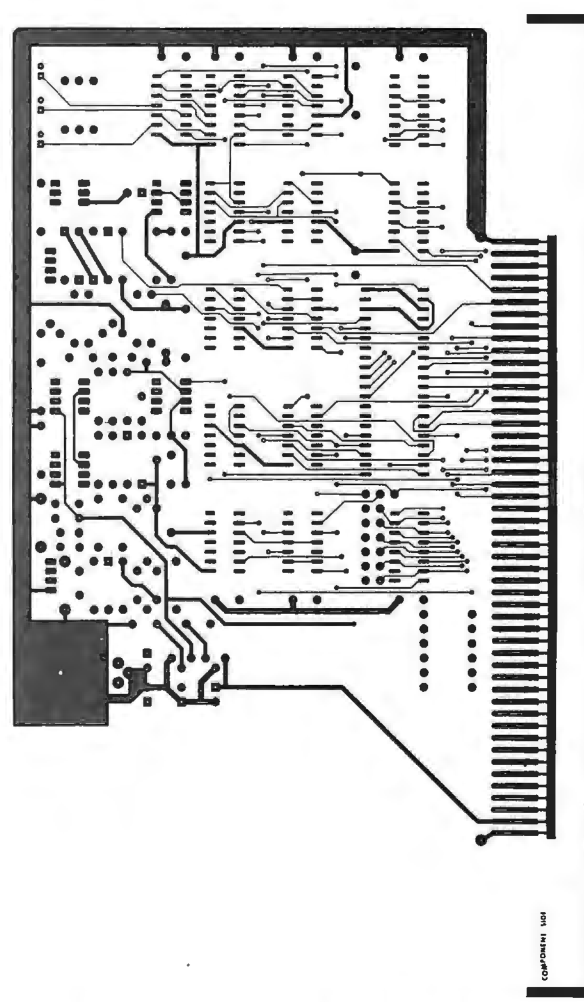


Fig. 7. Self-calibration circuit eliminates need for a frequency counter by comparing local and remote clocks.

Fig. 8A. Half-size foil patterns for pc boards are at right. Component placement diagram is on next page.





cy. The two LED's indicate in which direction the remote vco differs (less or greater than) from the controller vco.

Construction. The only practical way of assembling the controller part of the system is on a double-sided printed circuit board. The etching-and-drilling and component-placement guides for the board are shown in Fig. 8. Sockets are recommended for all IC's. However, the transistors, voltage regulators *VR2* and *VR3*, and optoisolator *IC3* can be mounted directly on the board. Main 5-volt regulator *VR1* is installed with the

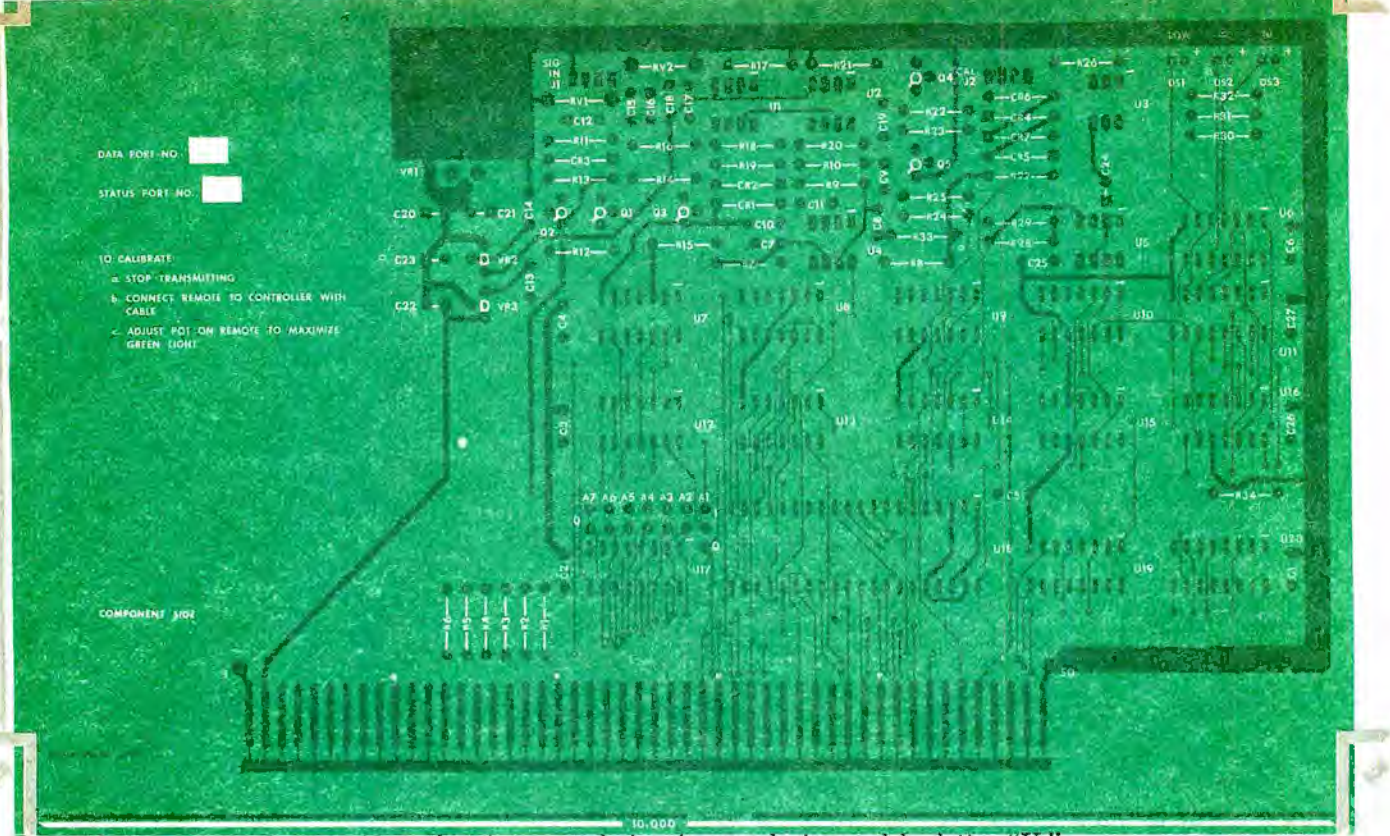


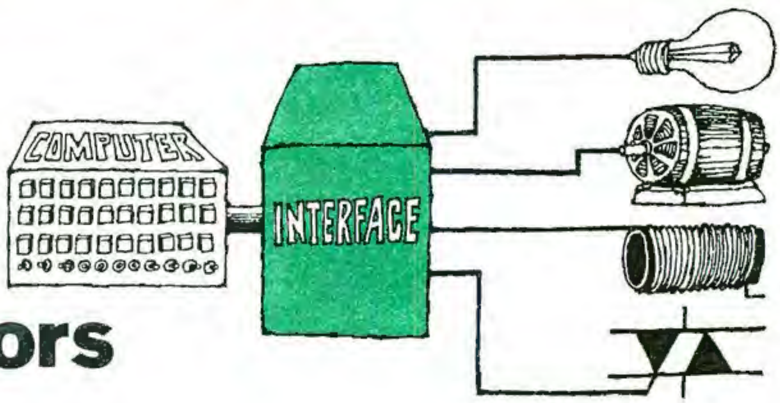
Fig. 8B. Component layout. Note that integrated circuits are designated by letter "U."

usual heat-sink and mounting hardware.

As you are installing the components on the board, pay careful attention to the polarization of diodes and capacitors. Install the IC's last, double-checking the pin-1 identifiers on each to be certain that they are installed properly in their respective sockets.

Coming Up. Next Month, in Part II of this article, we will cover the remote receivers to be used around the house. We will also detail the calibration procedure and present some sample software to use with the system. ◇

How To Interface Microprocessors



BY RALPH TENNY

A MICROPROCESSOR is a relatively complex device. Therefore, interfacing one with peripheral equipment may sometimes present a problem. Just as in any electronic interface, the solution lies in understanding how each side of the interface works and then *selecting* components and techniques to connect the two smoothly.

The microprocessor communicates with the *outside world* through three groups of signals as shown in Fig. 1. The address bus usually has between 12 and 16 lines. The data bus has 8, and there can be 1 to 12 control lines.

The internal operation of a processor is based on time—from an accurate oscillator called a clock. Some processors also require two clock signals (ϕ1 and ϕ2, where ϕ means phase) slightly displaced in time. They usually have different time durations, but do not overlap.

Typical machine cycles of operation are shown in Fig. 2 with the input shown in Fig. 2A and the output in Fig. 2B. Note that each machine cycle is divided into a number of time intervals. In each case, the ADDRESS data is sent out during the middle of interval I1 and holds steady until the middle of I4.

For the input or read cycle, the DATA INPUT strobe is high during I2 and drops during I3. For the output or write cycle, the WRITE strobe is low for most of I3. Each of the I1 through I4 time intervals is about 0.5 microsecond, which means that a read or write cycle will occur every 2 µs or 500,000 times/s.

During the read cycle, the processor is *asking* for data and during the write cycle, the processor is *sending* data. If there is to be communication between the processor and any other equipment, then some circuit must be "listening" for the data being sent or some circuit must

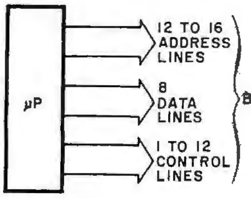


Fig. 1. Address, data, and control line bus allows microprocessor to communicate with outside world.

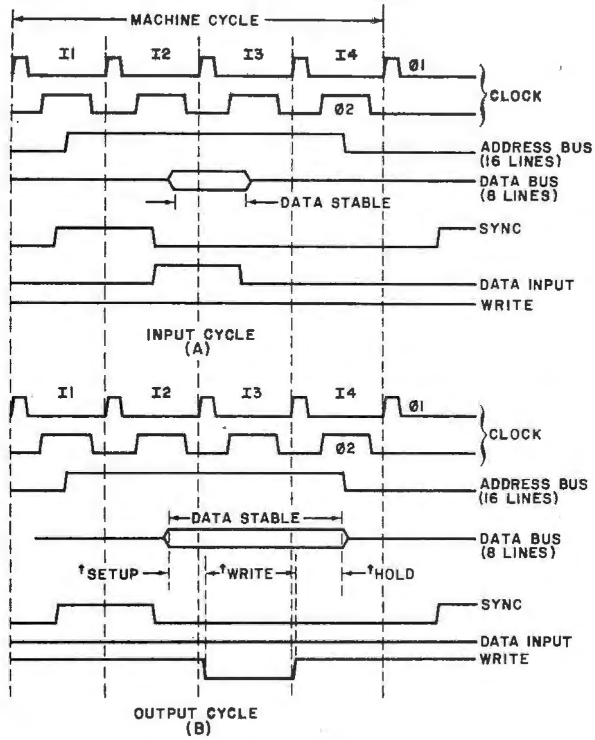


Fig. 2. Correct timing is secret of computer operation. Above are input cycle (A) and output cycle (B).

be able to furnish the data being requested. The processor may not know when its output is not received; but if the data it is requesting is not available, it may stop its operation. This is because part of the data input may include instructions for further operations.

To avoid chaos, one and only one device can send data to the processor during the input cycle. This device is selected by a unique address code that permits only the addressed device to "listen" to the data bus. A control signal (sometimes called a "handshake") tells the addressed device what to do with the data appearing on the data bus. If the three signals—data, address, and control—are to work properly, they must be coordinated in time and this is done by sending the common clock signal through the bus.

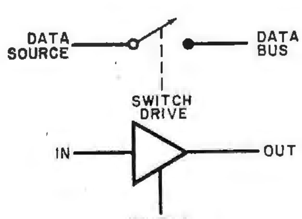


Fig. 3. Three-state buffer is like open switch when enabled.

In summary, successful data transfer between a processor and its associated elements requires three conditions: a unique address, control signals to enable the device being addressed, and means to disconnect data sources from the data bus when they are not specifically requested. Most processors will directly address 2^{16} (65536) different locations since they have 16 address lines.

The most common connect/disconnect system is the three-state buffer whose basic concept and logic diagram are shown in Fig. 3. Such a three-state buffer simulates an electronic switch that is closed only when the enable input is driven by the control signal. When it is not enabled, the output of the buffer is isolated from the internal circuits.

Timing is very critical for data transfer. Note the area marked DATA STABLE in Fig. 2A. The exact timing for data handling varies with different processors but the principle is the same: data must be available and stable for some minimum time and must remain stable for a short time after the three-state enable signal decays. This condition is usually met by using the enable (or DATA INPUT) signal to drive the three-state lines.

The processor output cycle is shown in Fig. 2B. The major difference between the input and output cycles is that, during the output cycle, the WRITE line is low for most of I3 and the DATA INPUT line remains low. Note that the output data from the processor (t_{write}) is available for only about 0.6 μs or less. This means that the IC's used must be able to "remember" the data that appears for such a short time.

Memories. IC memories—from simple flip-flops to RAM's—acquire data in one of two ways. Latches and flip-flops (for example the 74279 latch and the 7474 flip-flop) store their input data on either the positive- or negative-going pulses. In contrast, latches like the 7475, 7477, and 74100 store whatever data is at their D-inputs whenever their enable inputs go high. This is a somewhat subtle distinction and the user must be familiar with the various devices and their performance characteristics. In further contrast, changing data on the D-input of a 7474 will cause no output change until its clock input is driven high. The 7475, 7477, and 74100 outputs follow their D-input as long as their enable inputs are high. Finally, the 74279 latch requires alternate negative-going pulses on the S and R inputs to change the output.

Thus, the 7474 and 74279 devices can be considered to be strobed, or clocked memories, while the 7475's are gated-entry devices. Similar distinctions can be made with CMOS devices, and a careful study of the data sheets will be required to understand each device's operation.

Buffering plays an important part in interfacing a processor with any other device. One common output specification for address and data bus drives for many processors is one TTL load and 130 pF of capacitance. Therefore, if the processor is called upon to handle a number of external devices, some form of buffering must be used to prevent overload of the lines.

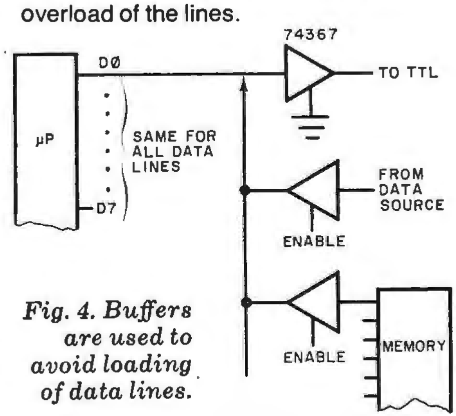
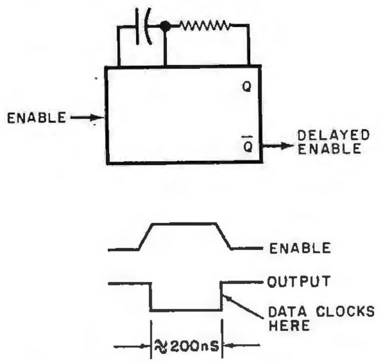


Fig. 4. Buffers are used to avoid loading of data lines.

For the address lines, a device similar to the 74365 or 74367 is recommended, while the data lines are buffered as shown in Fig. 4. If a number of TTL devices is to be driven, then the outgoing lines will also need buffering. Note that the memory lines are also buffered because of the TTL buffer load on the data line. Some medium-size systems use low-power Schottky TTL which has one fourth the loading of a standard TTL, but will drive five standard TTL loads.

Timing. In discussing timing in interfacing, we will refer to Fig. 2B and use a "worst-case" analysis. That is, we will decide which device specification is the

Fig. 5. Enable signal (below) can be delayed by one-shot set for any time delay.



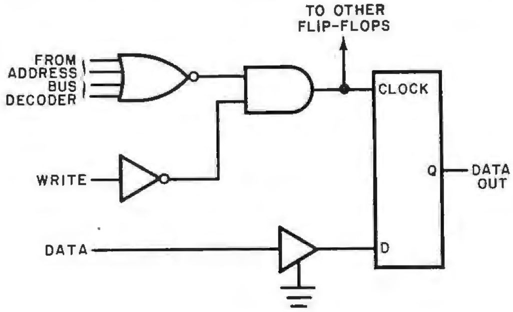


Fig. 6. Circuit above shows how one bit of data can be abstracted from data bus when data, address and handshake signals appear at the same time.

most likely to produce a failure and then be sure the selected part will work.

We will use a D flip-flop such as the 7474 (TTL) or 4013 (CMOS) to "remember" the data. Data set-up time (time the data has to be stable on the D-input before the rising edge of the clock pulse) for the 7474 is a minimum of 20 ns going from logic 0 to logic 1. For the CD4013, data set-up time is 20 ns typically and 50 ns maximum. Data hold time (time the data has to remain stable after the clock pulse edge) for the 7474 is a minimum of 5 ns going from logic 0 to logic 1. Propagation delay (time it takes data to pass through the flip-flop after the clock enters) from the clock pulse edge going from 0 to 1 for the 7474 is 10 ns (min.), 14 ns (typ.), and 25 ns (max.) Going from 1 to 0, it is 10 ns (min.), 20 ns (typ.), and 40 ns (max.). For the CD4013, propagation delay is 150 ns (typ.) and 300 ns (max.).

In a typical processor, the data set-up time when the WRITE line goes down (t_{set-up}) is 140 ns minimum. Data hold time after the trailing edge of the WRITE pulse (t_{hold}) is also 140 ns minimum. The WRITE pulse (t_{write}) is 500 ns min.

Since the maximum set-up time for either flip-flop is 50 ns, either edge of the WRITE pulse could be used to store data. Note the worst-case values: the minimum time for the processor and the maximum time for the flip-flops. Input timing for the same processor is almost handled automatically if the input strobe enables the three-state devices.

Since some processors have very tight timing on the data output bus, a delayed enable may be needed. The one-shot, shown in Fig. 5 will trigger on the leading edge of the enable signal; and, if the D flip-flop triggers on the rising edge of the one-shot output, it will now have the proper delay (set by the RC network).

A circuit that captures a data bit from the processor data bus is shown in Fig. 6. A NOR gate receives the correct decoded address signals, while the data is buffered by a permanently enabled buffer. The WRITE strobe is inverted. Although only one bit is recorded by this circuit, seven more can be clocked by the AND gate to capture the full 8-bit word when the address is entered.

The inverse function, inserting data onto the data bus is shown in Fig. 7. One bit stored in the flip-flop is sent to the processor (via the data bus) when the correct address is received.

Another important facet of input interfacing is the reset of the input data. Once a computer has "read" an input, it has no way to tell when that point is next sampled if the data then present is new data or the same as previously sampled. Therefore, the processor must either reset the data latch after the data has been read out, or must continuously sample the input line until the data changes state. Then the computer can interpret the data changes as valid.

Sample Interface. The most common man-machine interface element is a basic switch. Three ways to use a switch and a flip-flop to input data to a processor are shown in Fig. 8. In each case, a 7474 or 4013 will work; and the three examples show how different system responses can be obtained by setting the flip-flop output to logic 1 by various means. In each case, the immediate response to the switch closure is the same, but the effect on the processor system is different. An example of each type debouncing is shown in Fig. 9.

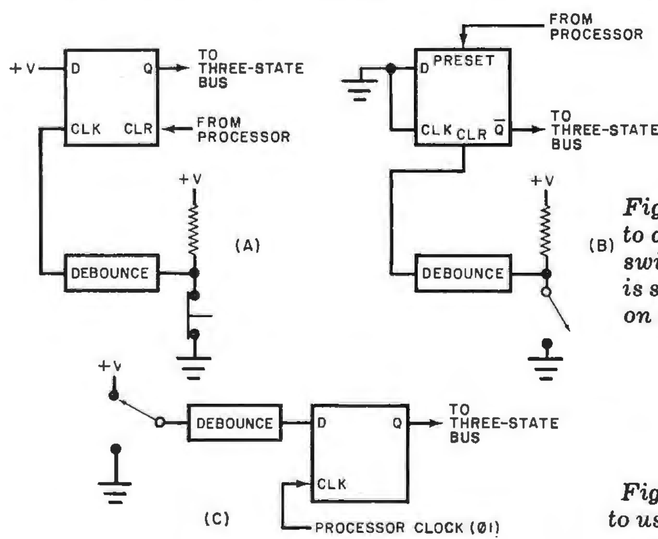


Fig. 8. Three ways, left, to debounce mechanical switch. In all, response is same, but effect on system is different.

Fig. 9. Below are 3 ways to use CMOS to debounce a mechanical switch.

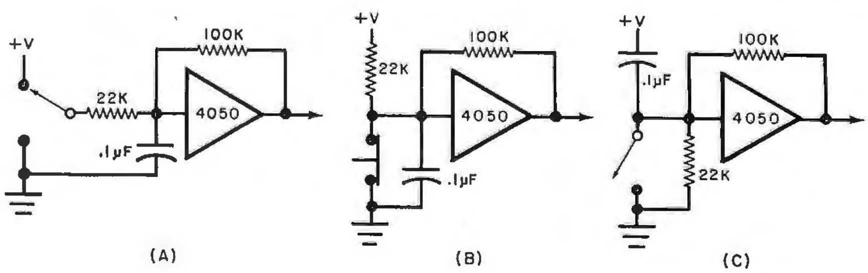
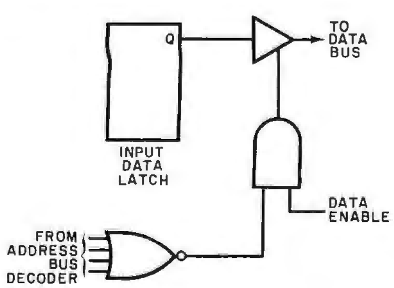


Fig. 7. With simultaneous access and enable signals, one bit of data can be passed to data bus via the buffer.



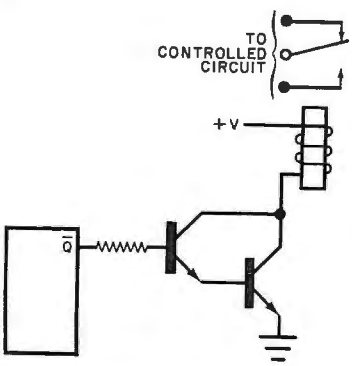


Fig. 10. Output bit can be used to turn on a power transistor and control relay.

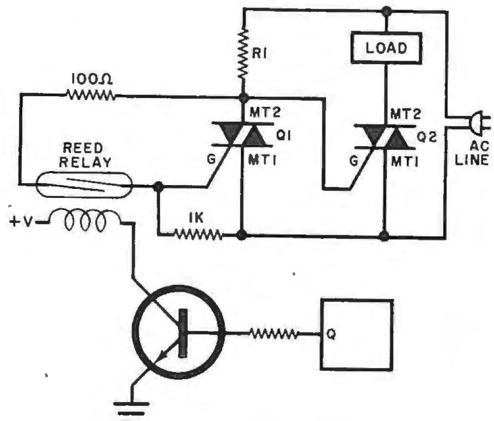


Fig. 11. Using output bit to turn on a triac eliminates RFI during switching operation.

In Fig. 8A, the switch drives the clock input high, which causes the Q output to go high. The processor can reset Q to a logic 0 through the clear input and the flip-flop is then ready to respond to another input. Figure 8B shows the clear input being driven, with the output taken from the not-Q and the flip-flop reset accomplished by the preset input. Note that the clear function overrides all other flip-flop inputs so that it will not reset until the switch opens. In Fig. 8C, the flip-flop samples the switch position using the processor clock. The Q output will then track the switch position. If the processor should reset the flip-flop, the Q output would still reflect the switch position after the next clock pulse. Note that the processor clock synchronizes the data entry to the system so that an input can never change while the processor is "reading" the data line.

Control Circuits. If a processor is to perform some useful work, it may have to control large amounts of power. Since its output may be the relatively low current of a flip-flop, some means must be found of controlling higher power. One method is to insert a relay as shown in Fig. 10. The use of Darlington transistors can be extended so that very high-power relays can be controlled. A power semiconductor such as an SCR or triac can be used instead of the relay. The circuit shown in Fig. 11 applies power to the load only at power-line zero crossings to eliminate r-f interference and line transients.

In Fig. 11, when *Q1* is turned on by the reed relay, there is no gate drive for *Q2*. When *Q1* is off, the gate drive for *Q2* is through *R1*. Note also that *R1* should be capable of handling the full line power while passing adequate current to trigger *Q2*.

In general, dc loads can be handled in the same way as ac loads except that suitable power transistors are used instead of triacs. As long as the dc operating voltages are derived from transformer-powered supplies, the major precautions to be observed are proper voltage insulation, and adequate heatsinking for the power semiconductors.

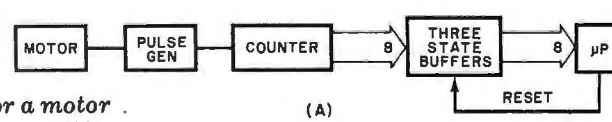
Motor Controls. In computer control of motor speed, there are two basic methods which can be used: open loop or closed loop. A simple example of the former merely involves setting a supply voltage for the motor and using the resulting motor speed. Depending on how the mechanical load varies, this method can allow motor speed to vary 10 percent or more.

Closed-loop control involves the continuous sampling of motor speed and setting a voltage (or other signal) to obtain the desired speed. Such control usually involves current sampling; and, if the motor or mechanism it is driving becomes jammed, closed-loop control attempts to drive the motor faster. As a result, either the motor, the power supply, or both, can be damaged. The solution to this problem lies beyond the scope of this article, however.

Sensing motor speed can be done in one of a number of ways. The simplest is accomplished by the circuit shown in Fig. 12A. A series of pulses from the motor drives a counter that is coupled to the processor through three-state buffers. The processor periodically reads the counter, resets it, and compares it with the count required by the program.

The motor rotation pulses can be generated by either of the two systems shown. In Fig. 12B, a sliver of shiny aluminum tape on a dark shaft allows light to bounce onto a photocell. The cell drives a suitable circuit that shapes the pulses for use by the counter. The slotted-disc approach shown in Fig. 12C also uses a light source and a photocell. Both of these methods are linear with changes in rpm, and the choice of which one to use depends on the amount of resolution required. If the motor speed tends to vary very quickly, the rpm must be sampled very often, so a large number of pulses per revolution is required to make accurate measurements. If the motor shaft operates at high speed, and the load has high inertia, one pulse per revolution may be sufficient. Another speed measuring technique involves the use of a tachometer, which is often a part of a motor and delivers a dc voltage linearly proportional to rpm. An analog-to-digital (A/D) converter must be used to convert the tachometer output into a signal suitable for the processor. The converter must also be furnished with address decoding and three-state bus drive. The advantage of the added complexity is that very close control can be maintained over motor speed. The basic logic approach is shown in Fig. 13A.

Another type of closed-loop control is shown in Fig. 13B. A small dc motor is



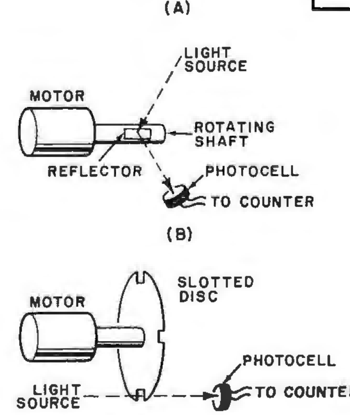


Fig. 12. Circuit for a motor control is shown at (A). Both (B) and (C) show ways to generate pulses that represent motor speed.

used to drive a potentiometer that sets the reference voltage level. If the motor has a large gear-reduction train and if the potentiometer is a multi-turn device, the reference voltage can be set very accurately. Note that, in this scheme, the processor is connected only to the control signals and not the actual power system.

A modern method of producing the necessary accurate reference voltage is shown in Fig. 13C. A D/A converter having an 8-bit resolution (1 part in 256 or 0.4 %) can do the required job. The data latches with address select are necessary to hold the D/A output between changes.

A final type of motor, extensively used with computers, is the stepping motor. It operates by having (typically) two to four drive coils and a rotor with an odd number of poles. When power is applied to a drive coil, the rotor locks in one position. If the alternate drive coil is energized, the first coil is turned off and the rotor increments once and locks. Thus, alternating pulses to the drive coils produce discrete increment rotation. Typically, a rotor may be advanced by 5° or 7.5° per step, which, when combined with a suitable gear train, can produce very fine resolution of mechanical position. Variation in the pulse rate produces excellent control of motor speed.

Other types of sensors that can be used with computers include various forms of limit and proximity detectors, item counters (for conveyor belts), and fire and intrusion detectors. ◇

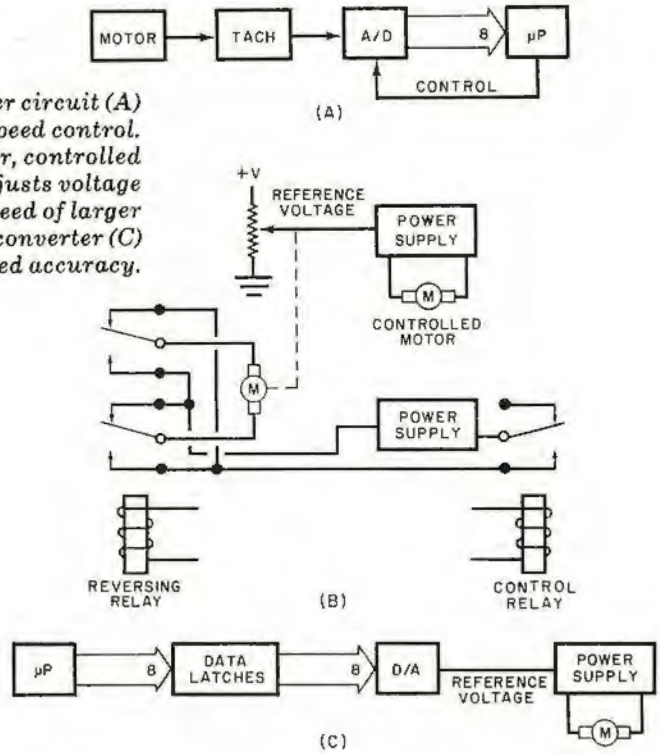


Fig. 13. Tachometer circuit (A) provides close speed control. In (B), small motor, controlled by computer, adjusts voltage to maintain speed of larger motor. Use of D/A converter (C) provides motor speed accuracy.

COMPUTER STORES:

A New Retailing Phenomenon

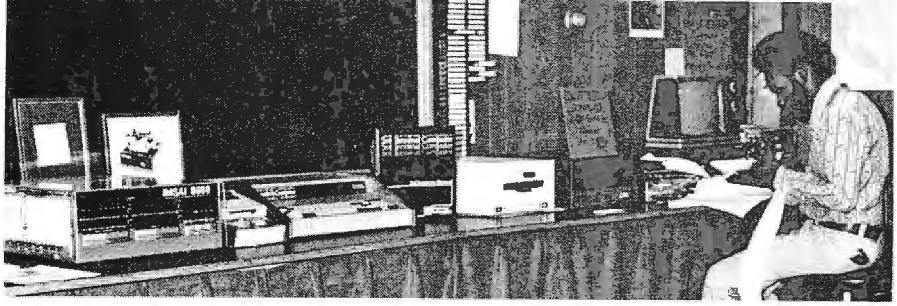
BY SHERMAN WANTZ

Independent shops like N.Y.'s Computer Mart sell many brands.

YESTERDAY, home computers were a science-fiction fantasy. Tomorrow, you'll probably find them under a heading of their own in the "Yellow Pages." And today there are already more than 900 home computer dealers in this country.

Not all computer dealers are alike, though. They range from part-time operations by computer hobbyists, through small departments in big electronics stores, to full-time specialist computer dealers. One way or another, if you live near a city with 50,000 people or more, you're likely to find a retail computer outlet of some kind nearby.

Finding it may be a problem, though (unless you're in California, which has about 25% of the nation's computer dealers). Most of the specialist stores have limited advertising budgets. And



Equipment is displayed in open in MicroComputer System's Florida store.

most "Yellow Pages" listings so far lump the home computer stores with the ones serving businesses, under such headings as "Computing Devices" or "Data Processing Equipment."

Certain key words in the company name will help you identify the home computer stores when you run across them: "Byte," " Computer," "Micro," "Digital" and "Data." Often, too, the names are deliberately un-stuffy, such as "Bits 'n' Bytes," "Kentucky Fried Computers," or "Digital Deli." But not all hobby computer dealers are so readily identified by name alone. Many electronics stores, such as Allied Electronics, Team Electronics and Radio Shack are entering this field.

What You'll Find. Like car dealers and furniture showrooms, computer stores are usually set up to encourage browsing. Most people have never touched a home computer yet and contact is addictive. So you'll seldom find counters separating you from the merchandise. Computers, video terminals, tape readers, keyboards and other equipment are likely to be displayed openly on tables. More often than not, some equipment will be connected and in operation. Ask a salesman if you can try your hand at any of the equipment that's running, or if he can demonstrate what one can do with a computer.

Independent computer stores give you the chance to compare and evaluate many different makes of computer equipment and systems. But not all computer stores are independent. MITS, for example, the company that makes the popular Altair line of microcomputers, has exclusive franchise agreements with dealers who sell no competitive products. Similarly, Heathkit computers are sold exclusively by Heath Electronic Centers and by mail from Heath's main office; Radio Shack stores will handle only the Radio Shack computer line (though Tandy Computer Stores, and probably others, will handle both Radio Shack and competing hardware).

However, computers aren't all you'll find at computer stores. You'll probably see a variety of terminals, for example, from the old standby Teletype to faster and fancier (or more limited, but cheaper) types of printer, plus several models of CRT terminals. You'll find a variety of peripheral and support types of computer equipment, too.

Along the walls of the store you'll certainly see shelves containing books, magazines, newsletters, promotional material, and probably assorted components, hand tools and test gear. If you're unfamiliar with computers, ask a salesman to suggest which magazines and books to buy, and which brochures to take home and study. These publications will supply answers to some of your initial questions (including the ones you may feel a bit shy about asking). More importantly, they'll also suggest a number of new questions you'll want to ask on your next visit.

Some of the most important merchandise the computer store has to offer is the least impressive looking: software. It is what computer people call the programs without which the hardware wouldn't work. The availability of programs is one of the main factors to consider when buying a computer system. A computer store can help you find out what software is available for your present or prospective system. Even more important, they can help you make the small but vital changes to the programs that may be needed to make it run on your particular system. What's more they can let you try out programs on the store's equipment to see if that software will suit your needs at home.

Your best introduction to computers is to play a game with one. Almost all stores have programs on hand for playing games, from simple Tic-Tac-Toe, through Blackjack, to a sophisticated game called "Startrek," patterned after the popular TV series.

For now, the heaviest emphasis is being placed on the microcomputer's entertainment value; but the availability of more advanced programs and equipment is changing that. Today's hobby computers are being used not only for playing games, but for controlling electro-mechanical devices and business and educational purposes.

Digital Cracker-Barrel. Like the old country store with its potbellied stove and cracker-barrel, the computer store is serving as a meeting and discussion center. Often, you can learn almost as much from talking with the customers as you can from the salesmen. While computer stores and Startrek attract their share of kids, you'll find a number of computer professionals and serious hobbyists there too. They may be programmers who work for one of the growing number of computer service companies; electronic technicians and engineers; students who've already taken computer courses in high school or college; amateur radio enthusiasts; or businessmen anxious to learn how a microcomputer can relieve them of tedious, routine chores.

Your presence at the computer store creates a bond between you and the other customers. You'll find it easy to strike up a conversation with one or more of those who are inspecting or operating equipment. They are as anxious to discuss computers as you are. Often, they'll be more knowledgeable about particular aspects of computer hardware or software than the store's own employees. People who already own computer models that you're considering for yourself can prove particularly helpful.

Look for a bulletin board on which the local computer club might announce the time and place of its next meeting. If you don't see such an announcement, ask one of the store's employees about the existence of a club. He should know. If you can find a club, you'll find a lot of the talk at your first few meetings rather hard to follow. But you'll also meet a lot of other hobbyists who'll be glad to explain things to you.

Special Store Services. Because

Demonstrating a microcomputer system in one of Byte Shops' chain of computer stores.

Altair carries mainly MITS gear.

computers are so complex, and so new to most people, computer customers need a lot of special services. And most computer stores provide them.

If you're handy enough to build some of your equipment from kits (and save up to 40 percent in the process), most stores will help you interpret unclear instructions and check out your work when you've finished. If you're unsure about your ability to build a particular kit, the store will often let you look over its construction manual, first, to get an idea of its degree of difficulty.

If you don't want to build a kit, but want an item that's not available in assembled form, many stores have technicians who'll build it for you—for a fee.

Computer stores usually have service facilities where you can take a malfunctioning computer (or the appropriate boards, if you can narrow down the problem) for testing and service. Bring a copy of your program, too; often, computer problems turn out to be in software, not in hardware.

Some technicians don't mind letting you watch and learn as they troubleshoot your system. But remember that you pay for most repairs at an hourly rate. Talking to the technician slows him down, and costs you money.

Stores will generally replace any defective parts in kits they've sold you (but not kits you've bought elsewhere). Servicing completed kits is usually done for the same flat fee or hourly rate as the manufacturer would charge, and saves you shipping time and charges.

Many stores provide consulting services, custom-designed hardware and software, and information on how to modify your system for better performance. More and more stores, in fact, are devoting a lot of attention to providing such services for small businesses (which gives them lots of experience for handling your problems, but may mean the technician or salesman you want to see is out if you just drop by unannounced). For the hobbyist, many stores give low-cost classes in computer and programming fundamentals.

For established customers, many stores will accept phone orders, often shipping out their orders overnight. Many also accept major credit cards.

When it's time to upgrade your system, the store where you bought your computer will usually have add-on module boards and peripherals, or be able to suggest equipment modifications, that will handle your requirements. If your old equipment simply can't be made to handle your new needs, many stores have bulletin boards where you can post your old equipment for sale. A few stores even take trade-ins.

If the store nearest you does not yet offer all of these services, don't be disappointed. The field is growing rapidly, and most stores, still small, must work hard to keep up.

Still, this is the calm before the storm, the lull before the home computer hobby *really* takes off. Someday you may have to take a numbered card and stand in line waiting for a salesman to take our order—as soon as he can free himself from the constantly jangling phone.

Beat the crowds, and begin now to visit the computer stores near you. Compare the lines of equipment each handles. Find out which stores give you the greatest bargains in quality merchandise and the most personal attention. Don't hesitate to ask about the availability of the services mentioned here. (But don't expect to find all of them in any one store, either.) Once you've found a store whose technical experts give you confidence, that's where you should go for help in setting up your own computer system.

And after you have your computer up and running, remember to keep in close touch with your computer store. In this fast-moving hobby, that's where much of the action is. ◇

QUICK HEX-DECIMAL CONVERSIONS

BY RAYMOND J. BELL

CONVERSION from hexadecimal to decimal or vice versa is sometimes required in microcomputers. The table presented here offers a rapid and efficient solution to this problem. It is suitable for integers between 0 and 65,535 (0_{16} to $FFFF_{16}$). It can also be easily expanded.

Here's an example of how to use the table. Say the hexadecimal number, $A7BD_{16}$, is to be converted to decimel. Starting with the right-most digit, D, look at the table's fourth-place digit and read down to D in that column. The decimal equivalent is 13. Repeat for the next digit in the third column. Here, the original number, B, corresponds to 176. Continuing with the next two digits, we read 1792 and 40960, respectively. Add these numbers, and the total is 42941, which is the decimal equivalent of $A7BD_{16}$.

The table can also be used in reverse to convert decimal numbers to hex. To convert 800_{10} to hex, for example, look in the table for the highest entry which does not exceed the number, which is 768. This corresponds to a 3 in the third hex digit. (The fourth digit is 0, so it can be ignored.) Next, 768 is subtracted from 800, yielding a remainder of 32. The highest table entry that does not exceed 32 is 32, which corresponds to a 2 in the second hex digit. Subtracting 32 from 32, the remainder is zero, which means the conversion is complete. (Note: to maintain proper relationship of the hex digits, we put 0 in the first hex digit, giving 320_{16} as the hex equivalent of 800_{16}, *not* 32_{16}, which is 50_{10}.)

The table can be expanded by multiplying the digits of 0 to 15 by the appropriate power of sixteen. To construct the fifth column of the table, multiply 16^5 (65,536) by 0, 1, 2 to 15. ◇

HEX-DECIMAL NUMBER TABLE

1st Place		2nd Place		3rd Place		4th Place	
Hex.	Dec.	Hex	Dec.	Hex.	Dec.	Hex	Dec.
0	0	0	0	0	0	0	0
1	4096	1	256	1	16	1	1
2	8192	2	512	2	32	2	2
3	12288	3	768	3	48	3	3
4	16384	4	1024	4	64	4	4
5	20480	5	1280	5	80	5	5
6	24576	6	1536	6	96	6	6
7	28672	7	1792	7	112	7	7
8	32768	8	2048	8	128	8	8
9	36864	9	2304	9	144	9	9
A	40960	A	2560	A	160	A	10
B	45056	B	2816	B	176	B	11
C	49152	C	3072	C	192	C	12
D	53248	D	3328	D	208	D	13
E	57344	E	3584	E	224	E	14
F	61440	F	3840	F	240	F	15

Sol-20. First it was THE SMALL COMPUTER. Now, it's THE SMALL COMPUTER SYSTEM.

A year ago, we introduced the Sol-20. It wasn't the first small computer. It was the first complete small computer with everything needed to get it up and on the air as it came from the factory. The keyboard, interfaces, extra memory, factory backup, and service notes were all there.

The results are in: Sol-20 is now the number one small computer in the world. Sols aren't the cheapest, just the most valuable.

We originally designed the Sol-20 as the heart of a complete computer system. So now to solve the problems of science, engineering, education, business management and control and manufacturing, we offer fixed price Sol systems in either kit or fully tested and assembled form. We offer language flexibility, Extended BASIC, ASSEMBLER, PILOT BASIC and FORTRAN IV. We offer Helios II/PTDOS, an extraordinarily capable disk operating system. And remember, though we call these small or personal computer systems, they have more power per dollar than anything ever offered. They provide performance fully comparable and often superior to mini-computer systems costing tens of thousands of dollars more.

What you get. What it costs.

Typical systems include Sol System I priced at $1649 in kit form, $2129 fully assembled and tested. Included are a Sol-20/8 with SOLOS personality module storing essential system software, an 8192 word memory, a 12" TV/video monitor, a cassette recorder with BASIC tape and all necessary cables.

Sol System II has the same equipment with a larger capacity 16,384 word memory. It sells for $1883 in kit form; $2283 fully assembled.

For even more demanding tasks, Sol System III features Sol-20/16 with SOLOS, 32,768 words of memory, the video monitor and the dual drive Helios II Disk Memory System with the PTDOS disk operating system and Extended DISK BASIC Diskette. Prices, $4750 in kit form, $5450 fully assembled and tested.

More information.

For the most recent literature and a demonstration, see your dealer listed below. Or if more convenient, contact us directly. Please address Processor Technology Corporation, 7100 Johnson Industrial Drive, Pleasanton, CA 94566. Phone (415) 829-2600.

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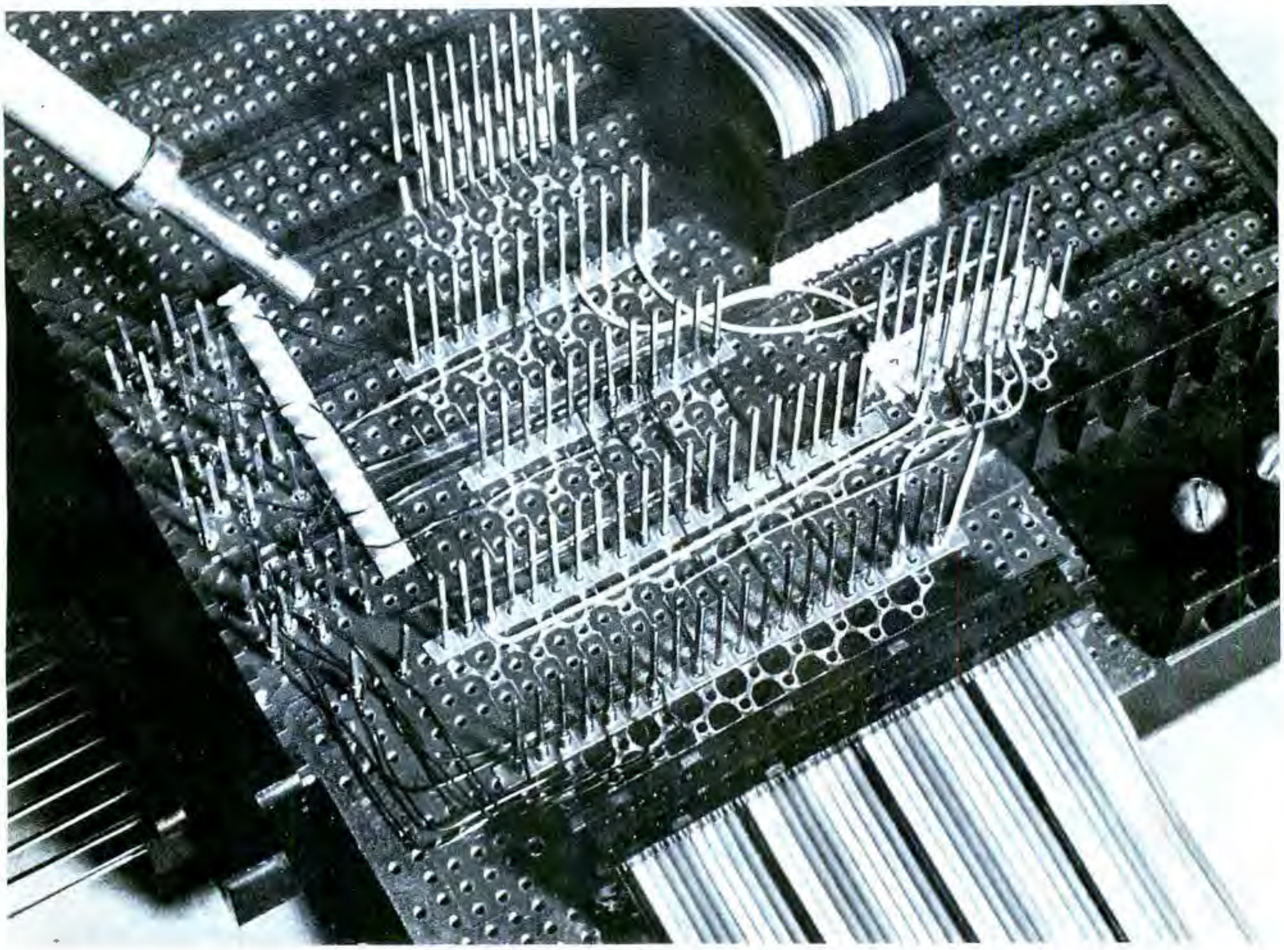
CIRCLE NO 73 ON FREE INFORMATION CARD



WIRE-WRAPPING TECHNIQUES FOR COMPUTER HOBBYISTS

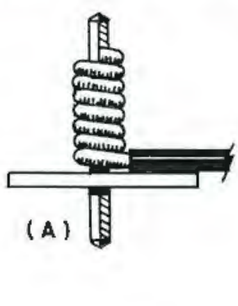
Modern techniques save assembly time for more complex electronic projects

BY ADOLPH MANGIERI

TRADITIONALLY, electronics hobbyists and experimenters have relied on point-to-point wiring and printed circuits in assembling their projects. This was fine when projects were relatively simple and had few IC component counts. With the coming of home computers, however, traditional wiring methods left much to be desired.

Now, an A/D converter, an I/O port, or a complete microcomputer can be assembled without preparing artwork or etching a complex double-sided pc board. In addition, the circuit can be enlarged or revised with ease. Best of all, a soldering iron is never required. Particularly advantageous for computer projects where wiring flexibility is a must, Wire Wrapping can be used with almost any type of electronic construction.

Propelled by the growing numbers of microcomputer enthusiasts, hobbyist Wire Wrapping has come into its own, spawning a broad range of inexpensive tools and accessories. Owners of Altair 8800 and IMSAI 8080 microcomputers, for example, can obtain commercial Wire Wrap plug boards that are compatible with their bus systems. In addition, you can choose between or combine conventional tip-loaded wrapping, bare-wire bus strapping, and speedy insulated-wire bus strapping with a new multimode tool from Vector Electronic.



Standard Wrap

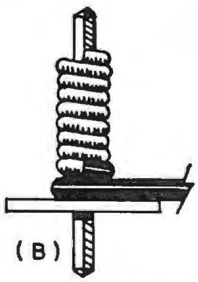
The Connection. A Wire Wrap connection consists of a minimum of six closely wound turns of wire applied under tension to a post with a special square cross section. The standard Wire Wrap connection is shown in drawing A.

The modified wrap shown in drawing B includes an additional half-turn or so of insulated wire. This wrap can be used when extreme mechanical vibrations might otherwise cause wire breakage. (The modified wrap also precludes short circuits to a ground plane.)

As shown in drawing C, the tip of the Wire Wrap tool includes a centrally located hole that accommodates the wrap post. An off-center hole, or "wire tunnel," accepts the end of the wire. As the tool is rotated, wire coming from the wire tunnel negotiates a sharp 90° bend that results in drag and tension on the wire. Under tension, the wire becomes firmly imbedded against the sharp edges of the post to form a gas-tight contact.

Bus strapping, shown in drawing D, permits rapid interconnection of many posts with a single unbroken length of wire, avoiding repeated insertion of the wire end into the tunnel. Conventionally, continuous bus strapping requires the use of bare wire, which imposes some wiring limitations.

Typical Wire Wrap tools, including power wrapper.



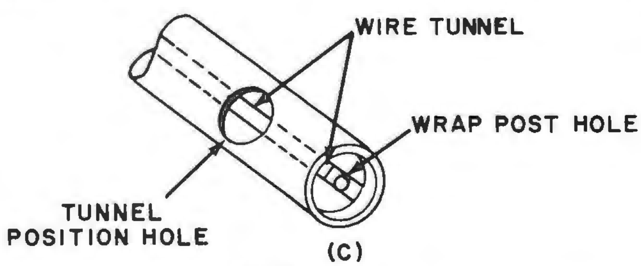
Modified Wrap

Wire Wrapping tools for conventional wrapping are available from Vector Electronic (12460 Gladstone Ave., Sylmar, CA 91342) and OK Machine and Tool Corp., (3455 Conner St., Bronx, NY 10475). Both companies also offer electrically powered automatic tools that greatly reduce operator fatigue and vastly speed up the wiring.

Slit-N-Wrap Tool. A new and rather unique tool, the Vector Electronic Model P180 "Slit-N-Wrap" tool, is a spool-fed insulated-wire bus strapping device that eliminates the need to cut wire and strip away insulation. This high-speed wrapping tool permits a bus to be strapped to the ground plane without the usual danger of causing short circuits.

A 100′ (30.5-m) spool of No. 28 polyurethane-nylon insulated wire fastens to the top of the Slit-N-Wrap tool handle. The wire is then fed down through a hole in the body of the tool and exits through the wire tunnel. As the tool is rotated clockwise, a sharp slitting edge at the tool's tip splits the insulation on the wire lengthwise. As wiring proceeds, the tension on the wire and pressure at the contact points force the insulation aside to allow the wire to become firmly imbedded against the post. The tool provides at least 10,000 perfect wraps before replacement of the slitting tip becomes necessary. The tool itself is designed to be used on standard 0.025″ (0.64-mm) square Wire Wrap posts.

You can "pencil wire" the solder-through insulated wire used with the Slit-N-Wrap tool around any size lug or terminal and solder directly through the insulation, which vaporizes when soldering heat is applied. The Slit-N-Wrap tool also conventionally wraps or straps No. 26 through No. 30 bare and Kynar-insulated wire.



Wrap Tool Tip

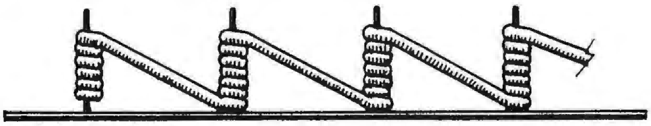
The Slit-N-Wrap tool comes with two spools and the Model P138 chisel knife and wire-forming tool. Replacement spools of wire are available in different colored insulation.

Wrap-N-Strap Tools. For conventional wrapping of bare and Kynar-insulated wire, the Vector Dual-Way Wrap-N-Strap tools operate in either direction. These are highly efficient tools, with slim handles that can be twirled rapidly between the fingers. The tip of the tool is cross-slotted and recessed to permit insertion of the wire ends without having to upend the tool.

The Model P160 Wrap-N-Strap tool wraps No. 26 through No. 30 wire onto 0.025″ square wrap posts. The tool can be used for bus strapping by passing bare wire down through its hollow handle. Similar, but with the wire spool and bracket located atop the handle, the Vector Model P160-2A-1 wrap tool is more convenient for strapping. With the spool-fed wire retracted, this tool is also used for tip-loaded wrapping of bare and insulated wire.

For unwrapping No. 26 through No. 30 wire, the Model P160-1A Dual-Way unwrap tool has a self-adjusting sleeve that contains the unravelled wire for easy removal from the wrap post. The Model P160-9 Wrap-N-Unwrap tool is

double-ended. It can wrap and unwrap wire but it cannot be used for strapping. Tools for wrapping No. 22 through No. 26 wire onto large 0.045" (1.14-mm) square posts and 0.031" × 0.062" (0.79 × 1.57 mm) posts include the Model P160-6 Wrap-N-Strap tool, the Model P160-6-1 Spool Wrap-N-Strap tool with top-mounted wire spool, and Model P160-7 unwrap tool. These dual-way tools have larger grips for greater torque to wrap heavier wire.



(D)

Bus Strapping

Another good wrap/unwrap tool for standard 0.025" Wire Wrap posts is the Model WSU-30 from OK Machine and Tool Corp. Built into the side of this tool is a hardened-steel cutter that neatly and quickly removes Kynar insulation from the wrap wire.

With the extensive Wire Wrapped microcomputer system, powered wrapping, strapping, and unwrapping is advantageous. These tasks are performed almost instantaneously by The Vector Model P160-4R and the OK Model BW 630 cordless power wrapping tools. Both tools wrap in the clockwise direction. The Vector tool has a chuck that accepts the Models P160-2A wrap, P160-9 double-ended, and P180 Slit-N-Wrap tools. It can also be used for strapping when the Model P160-5 spool strapping adapter is used. The OK Model BW 630 power tool comes with wrapping bit and sleeve.

For powered unwrapping, the Model P160-4L cordless power tool from Vector rotates in the counterclockwise direction and accepts the bits of the Models P160-1A and P160-7 unwrap tools. Vector's Model P160-4T power tool kit consists of the Model P160-4R power driver and the Model P180 Slit-N-Wrap tool already installed.

Accessories. A variety of accessories and hardware that ease the task of the Wire Wrap user are available. Vector, for example, has a number of circuit boards, circuit card connectors, and wrap posts. Both Vector and OK offer a variety of dual-in-line (DIP) Wire Wrap sockets for IC's, numeric LED displays, and DIP switches.

The Vector No. 8800V universal microcomputer/processor plugboard is bus-compatible with the Altair 8800 and IMSAI 8080 microcomputers. The P-pattern, double-clad etched and drilled board provides separate ground and wiring planes that assure effective noise suppression. The board measures 10" × 5.3" (25.4 × 13.5 cm) and has 100 edge contacts, arranged 50 contacts to a side. This board accommodates two 40-pin, eight 24-pin, or 36 16- or 14-pin DIP IC's. It also has two finned heat sinks to accommodate voltage regulators. Mating sockets for this board include the Vector No. R681 solder-tail socket with Altair coding and the No. R681-1 wrap-post connector. The Vector No. 4350 logic and interface board that measures 9" × 7" (22.9 × 17.8 cm) can accommodate a medium-sized microcomputer on one or two boards; it provides 80 edge contacts, arranged 40 per side.

A single-clad, etched board that measures 8" × 4.5" (20.3 × 11.4 cm) can be used to assemble a microcomputer trainer with limited memory. For Wire Wrapping, the Vector No. 3677-7 ground-plane board has a continuous grid with copper etched back from the holes to form a relieved ground plane that clears the wrap posts. Power buses can be assembled topside on this board with Vector's No. T107 punched copper bus strips. To ground a wrap post, a self-gripping No. T112 bus link can be slipped onto the post before wrapping the wire; its tab is then soldered to the ground plane.

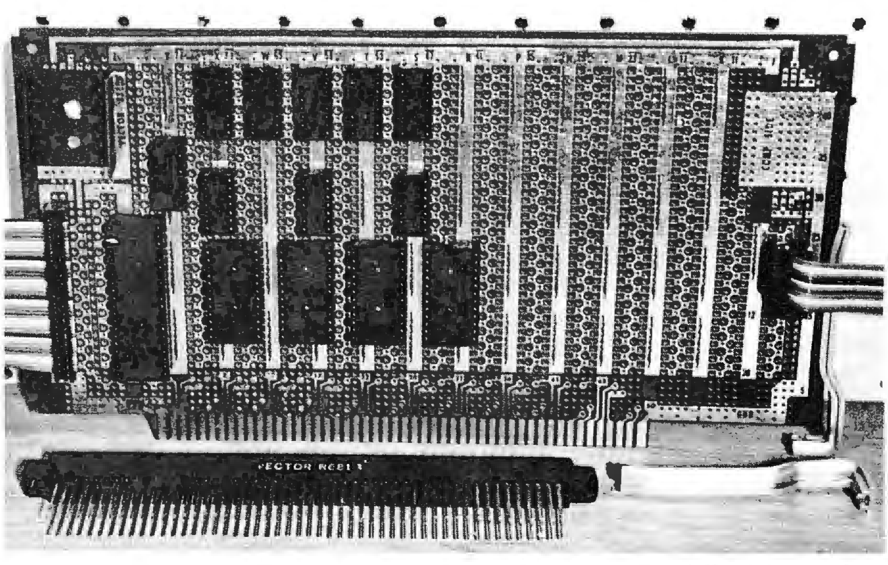
The Vector No. 3677-6 padboard has interdigitized power and ground bus arrays of oval pads that accept all DIP sockets for either Wire Wrapping or soldered wiring.

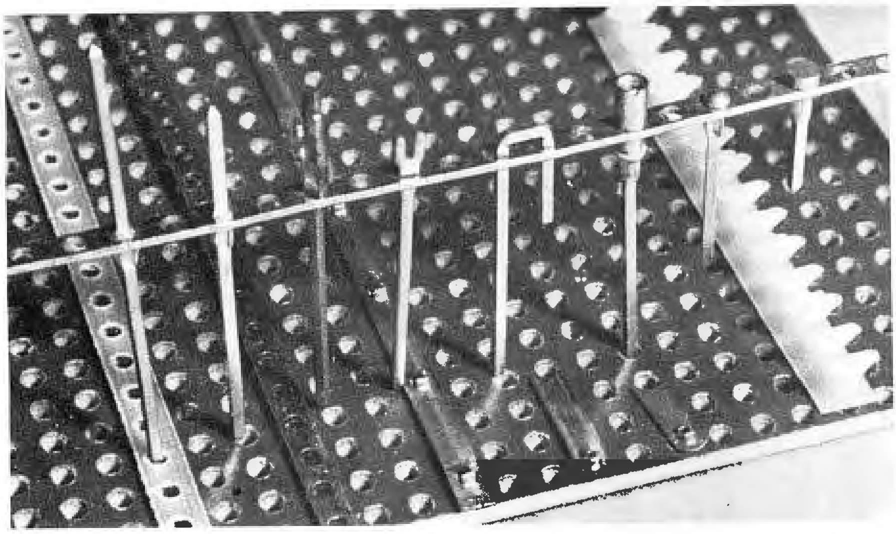
Wrap-post board pins can be pushed into P-pattern board holes with inexpensive pin-insertion tools For soldered installations of discrete components, the rugged and versatile Vector No. T49 Klipwrap post can be used, inserted with a No. P156 insertion tool. It has a stepped fork at one end, allowing temporary snap-in connections. The No. T44 Miniwrap pin, installed with a No. A13 insertion tool, has a small solder slot at one end and can be used for terminating diodes, transistors, etc. Soldered to a foil trace or crimped to insulated board, the No. K32 J pin has many uses.

Perhaps the most useful of the double-ended wrap posts is the Vector No. T46-3 pin, inserted with a No. P133B tool; it accommodates three or four wraps at each end. The No. T46-5 is a similar but slightly shorter wrap post. Fitted into edge contact pads of the No. 8800V board, the single-ended No. T46-4 pin affords two wrapping levels. Where one wrap level will suffice, the short single-ended No. T51 pin can be used to pass a circuit trace from one to the other side of a circuit board.

The No. R32 gold-plated socket pin from Vector can be used to assemble transistor and DIP IC sockets. When installing these or any of the other Vector wrap pins, the No. MB45-20-062 P-pat-

Vector 8800V Wire Wrap Board for 8080 microcomputers.





Assortment of terminal-pin hardware for Wire Wrapping.

tern perforated alignment block should be used to assure perpendicular alignment of the posts.

A handy item to have around when Wire Wrapping a project is the Model WD-30-B wire dispenser from OK. It holds a 100′ spool of wire that feeds out through a hole in the side of the case to any length required. Built into the dispenser are a wire cutter and an insulation stripper.

Working With Wire Wrap. Rapid bus strapping with the Slit-N-Wrap tool requires very little practice. First, pull out 1″ (2.54 cm) of wire, position the tool on the post, and hold the free end of the wire. Rotate the tool clockwise only and wrap seven or eight closely wound turns. You can keep track of the number of turns by counting the number of times the tunnel position marker passes a given point. Lift the tool off the post and form a loose strain relief loop by circling the post with the wrap tool. Form the wire down beside the post and hold it against the board with the plastic end of the No. P183 knife and forming tool.

With the wire tunnel marker up and the wire and tool in a nearly straight line, pull the tool to the next post and wrap as above. At the last post, add an extra turn and omit the strain relief loop. Either snip or break the wire by swinging the tool back and forth. Then use the chisel knife to cut off the excess wire at the first wrap post. To avoid snarling the wire, arrange your work so that you can complete the entire run without setting down the wrap tool.

Tip-loaded wrapping of Slit-N-Wrap wire with the Model P180 tool comes in handy at times. (You should use a heat sink when soldering a pencil-wired Slit-N-Wrap connection.) The pencil-wired strain relief loop can be omitted, using simpler methods of strain relief, which preclude bending of wrap posts when installing a direct taut connection. As you wrap the first turn, observe the preceding wrap post for evidence of strain or pulling. If pulling is evident, reverse the direction of tool rotation part way once or twice as you slowly form the initial turn.

Another useful method is to position the wire tunnel marker to the far side of the post before anchoring and prior to wrapping the wire. Also, it is very useful to direct the wire tunnel marker and, hence, the direction of the wire as you prefer before lifting the strapping tool from the post. Wire coming off the posts at higher levels creates a "Sawtooth" effect than can interfere with other wiring. One way to avoid this problem is to pencil wire a spiralling turn down the post before removing the tool from the post and, similarly, to reach a higher wrap level on another post.

Conventional tip-loaded wrapping of bare and Kynar-insulated wire proceeds rapidly with the easy-to-load wrap tools. To wrap efficiently, roll the handle of the tool fully as far as you can between your thumb and fingers. When using insulated wire, strip away 1″ of the insulation, taking care to avoid wire nicks. (A special Wire Wrap insulation stripper here will obviate nicks.) Then run the wire insulation right up to or around the post to preclude short circuits. You can easily form the modified wrap with the insulated turn by inserting a bit of the insulated portion of the wire into the wire tunnel. Where it can be used, bare-wire strapping and wrapping saves time. Spool-fed strapping avoids wire snarls and more readily permits pencil wiring of connections around any size terminal or lug. Do not forget: Pencil-wired connections *must* be soldered.

You will discover that wire size plays a part in Wire Wrapping. Commonly used No. 30 bare and insulated wire is readily available in economical bulk spools and in assorted lengths of precut and prestripped wire with a variety of insulation colors. The use of prestripped wire affords convenience, but the resulting slack wire can impair high-frequency circuit performance.

Easily wrapped and routed No. 30 wire has little or no tendency to place wrap posts under strain with the taut connection. However, the wire kinks or bends easily if you miss the wire tunnel when tip-loading the wrap tool.

Excellent for power and ground busing, No. 26 wire is much less easily formed and routed on the crowded Wire Wrapped board. The wire has a pronounced tendency to place posts under strain and requires strain relief with taut connections. As a compromise, No. 28 wire is easily tip-loaded and routed and easily strain relieved when required.

Powered wrapping with cordless power tools is ideal for large assembly projects. You will quickly develop proper timing of the motor to achieve efficient wrapping techniques. Very forceful in action, the power tool pulls the wire around the wrap post a half turn or so if you loosely anchor the wire. You can use this to your advantage to make the modified wrap connection.

At first, you may tend to under-wrap connections, leaving a flying end, when using a power tool. You can compensate for this by lifting the power tool partway to examine the wrap and then lowering the tool to complete the job.

With the heavier wire sizes, powered wrapping places even more strain and tension on wrap posts when installing a taut connection. One remedy is to leave some slack wire and pin the wire to the board before wrapping. Alternatively, you can manually advance the rotor one turn before starting the power tool.

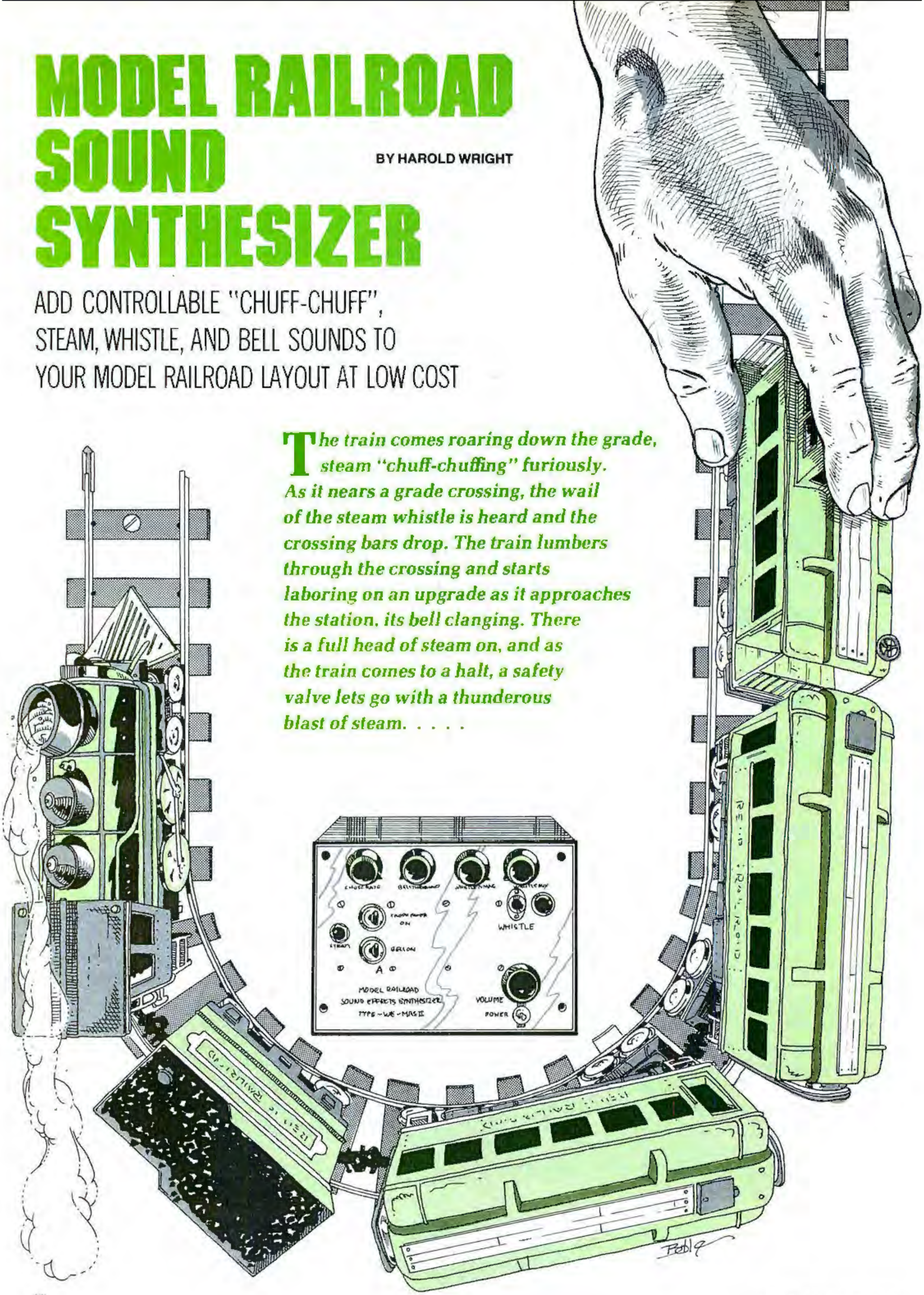
In Conclusion. As you become familiar with the Wire Wrap approach to circuit assembly, you will discover that this scheme is much more efficient than the traditional approaches used in project wiring. With a little practice, you will soon master the proper tool-handling techniques to use to produce perfect Wire Wrapped joints every time. It may not be long before you retire your soldering iron for good. ◇

MODEL RAILROAD SOUND SYNTHESIZER

BY HAROLD WRIGHT

ADD CONTROLLABLE "CHUFF-CHUFF", STEAM, WHISTLE, AND BELL SOUNDS TO YOUR MODEL RAILROAD LAYOUT AT LOW COST

The train comes roaring down the grade, steam "chuff-chuffing" furiously. As it nears a grade crossing, the wail of the steam whistle is heard and the crossing bars drop. The train lumbers through the crossing and starts laboring on an upgrade as it approaches the station, its bell clanging. There is a full head of steam on, and as the train comes to a halt, a safety valve lets go with a thunderous blast of steam. . . . .



All of the sound effects described on the preceding page can be obtained in your model train layout if you build this sound synthesizer. Using relatively simple circuits and readily available components, the system can be assembled easily in a few hours. The loudness of the sounds obtained is determined by the audio amplifier that you use in conjunction with the synthesizer.

Since most modern railroad layouts are already equipped with electrically operated switches, signal lights, and speed controls, the addition of the sound synthesizer will have the effect of turning your system from a silent movie into one with sound. The synthesized sounds are quite realistic and are of a wide variety. They can range from those of a distant, rapidly approaching train, with the volume increasing as the train approaches and slows down for the station, to the noise of wheels slipping on an engine trying to start with too large a load.

A block diagram of the complete synthesizer is shown in Fig. 1. It consists of four more-or-less independent circuits: a "chuff-chuff" generator for the steam sound, a whistle generator, a bell circuit, and a three-channel signal mixer.

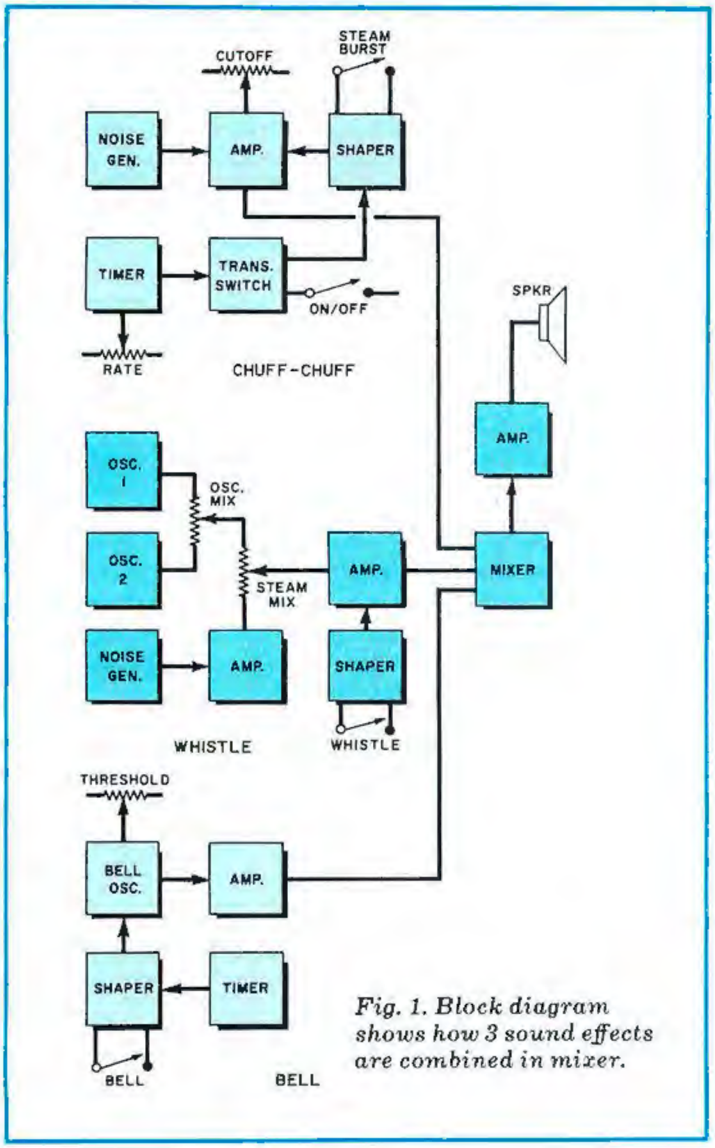


Fig. 1. Block diagram shows how 3 sound effects are combined in mixer.

Chuff-Chuff. As shown in Fig. 2, transistor *Q1* is operated in the avalanche mode and generates a steady white noise (hiss) signal across *R2*. This signal is applied to amplifier *Q3*, which is adjusted to a point just below cutoff by *R10*.

Timer *IC1* produces pulses at a rate

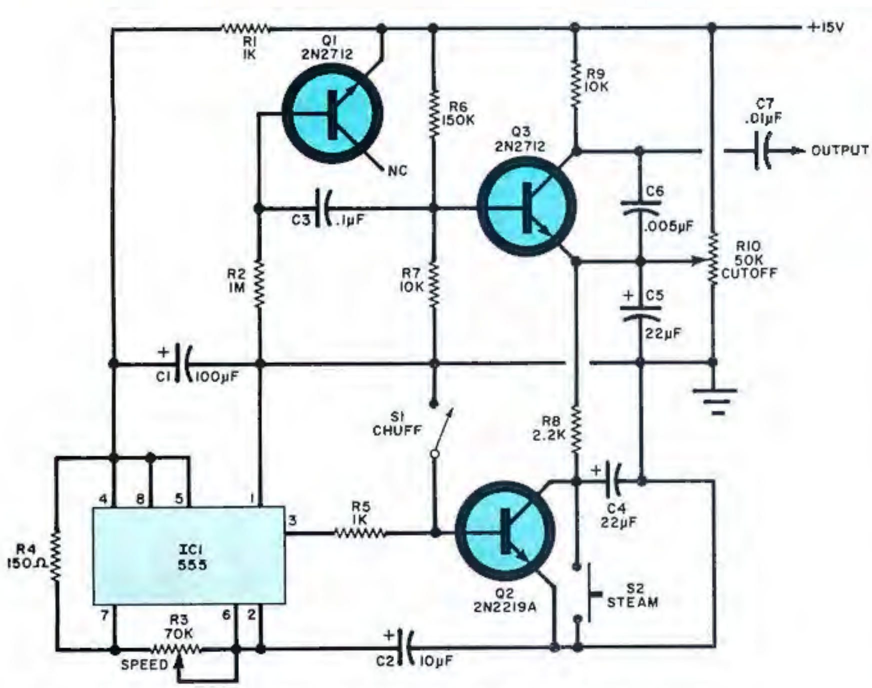


Fig. 2. Steam sound comes from white-noise generator Q1.

PARTS LIST
CHUFF-CHUFF

C1—100-µF, 25-V electrolytic capacitor
C2—10-µF, 25-V electrolytic capacitor
C3—0.1-µF capacitor
C4,C5—22-µF, 25-V electrolytic capacitor
C6—0.005-µF capacitor
C7—0.01-µF capacitor
IC1—555 timer
Q1,Q3—2N2712 transistor
Q2—2N2219 transistor
The following resistors are ½-W carbon composition unless otherwise noted:
R1,R5—1000 ohms
R2—1 megohm
R3—70,000-ohm panel-mount potentiometer
R4—150 ohms
R6—150,000 ohms
R7,R9—10,000 ohms
R8—2200 ohms
R10—50,000-ohm board-mount potentiometer
S1—Spst switch
S2—Spst NO pushbutton switch

determined by *C2* and the setting of *R3*. Thus, *R3* is the chuff-chuff speed control and, with the values shown, can be set to provide sounds from those of a slow starting engine to very fast bursts of steam. Make sure that *R4* is not less than 150 ohms or the speed setting will be unstable.

The pulses from *IC1* are applied to *Q2*, which functions as an electronic switch. When *Q2* conducts, *R8* is shunted across the lower portion of *R10*, thus bringing *Q3* above cutoff. Transistor *Q3* then amplifies for one chuff. Capacitor *C6* rolls off some of the high frequencies to produce a softer steam sound. Capacitors *C4* and *C5* shape the starting and stopping of the individual chuffs. The +15-volt supply is decoupled by *R1/C1* to keep any pulses from getting into the remainder of the circuit.

Whistle. In this circuit, shown in Fig. 3, transistor *Q1* is a fixed tuned twin-T oscillator. The circuit for *Q2* is almost identical except for tuning control *R11*. The second oscillator can be tuned from a zero-beat with the first oscillator to a frequency that simulates the two-tone effect similar to that heard from a diesel engine. Points between can be selected for a variety of sounds, including a steam whistle.

Because the outputs of the two oscillators are fed to potentiometer *R12*, a further range of possible tones exists. The power supply to the oscillators is decoupled by *R13* and *C12*.

Transistor *Q3* is connected as an avalanche-mode white-noise source, whose output (across *R14*) is amplified by *Q4*. The output of *Q4* is fed to potentiometer *R19* along with the output of the two tone oscillators. The final mix of tone and steam is fed to amplifier *Q5*.

When whistle pushbutton *S1* is open, resistors *R22* and *R25* keep the emitter of *Q5* at a higher potential than the base, so that the transistor is cut off. When *S1* is closed, *R24* is grounded, shunting it across *R25*. This causes *C19* to reach a lower charge level since it is now being discharged by *R24*. Thus the start of each whistle is made less abrupt to simulate a real steam whistle. When *S1* is released, the recharging of *C18* removes the terminal thump.

Bell. In the circuit in Fig. 4, transistor *Q1* operates as a twin-T oscillator with potentiometer *R7* set so that the circuit is just below the point of oscillation. If this control is set too low, the bell sound will be dull and have too short a decay time. Transistor *Q2* is an emitter follower isolator between the bell oscillator and the mixer stage. Timer *IC1* generates pulses to produce repetitive ringing with the rate (about one per second) determined by *R15* and *C9*. The value of *R15* can be reduced to increase the ringing rate of the bell.

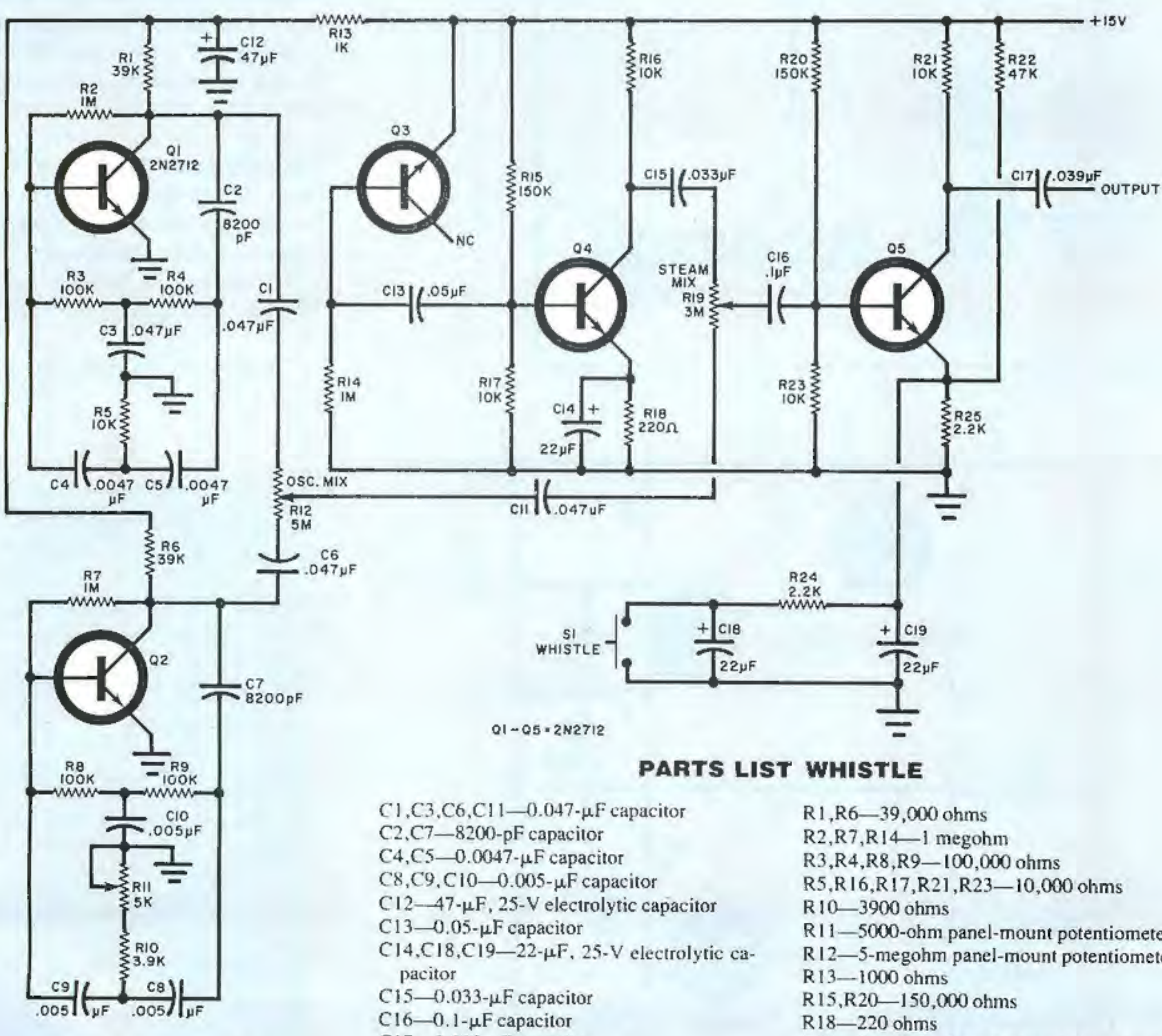
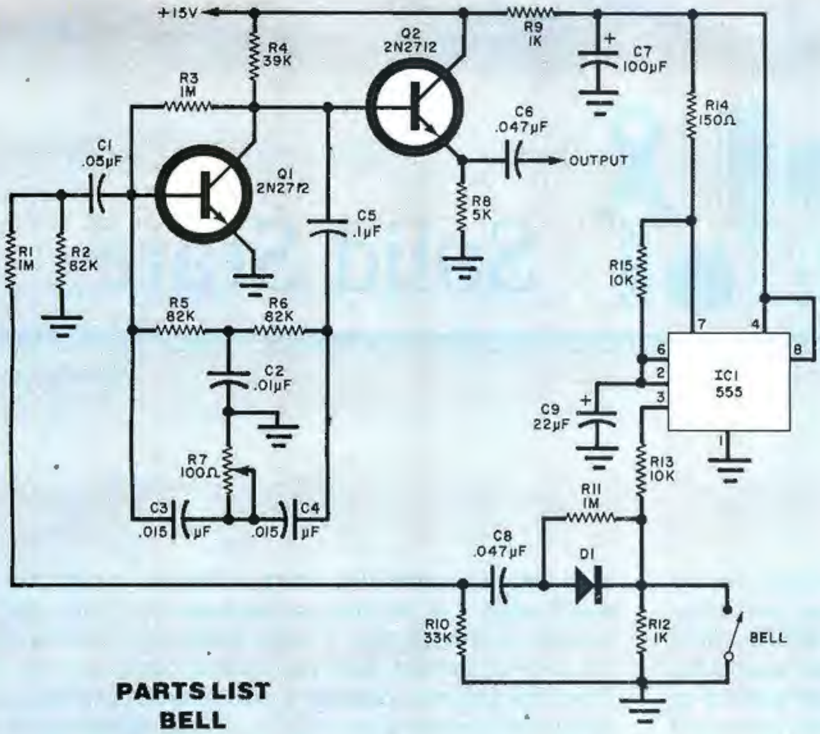


Fig. 3. Oscillator Q1 and Q2 take white noise from Q3 to create steam plus whistle.

PARTS LIST WHISTLE

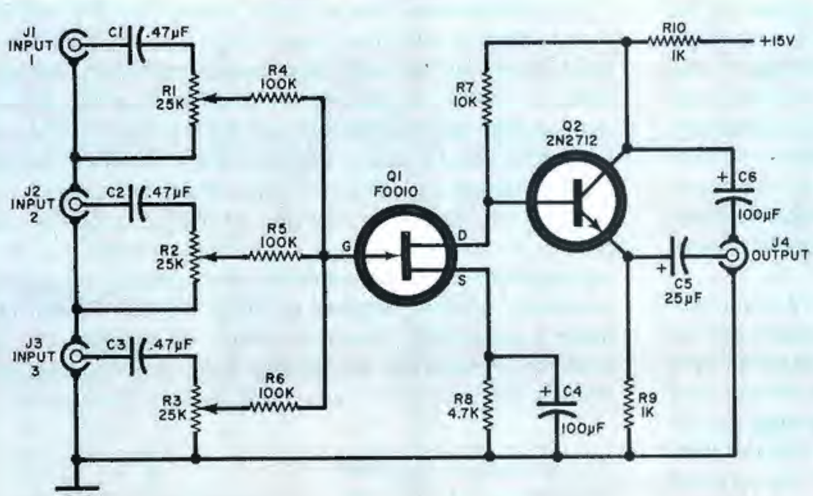
C1,C3,C6,C11—0.047-µF capacitor
C2,C7—8200-pF capacitor
C4,C5—0.0047-µF capacitor
C8,C9,C10—0.005-µF capacitor
C12—47-µF, 25-V electrolytic capacitor
C13—0.05-µF capacitor
C14,C18,C19—22-µF, 25-V electrolytic capacitor
C15—0.033-µF capacitor
C16—0.1-µF capacitor
C17—0.039-µF capacitor
Q1 through Q5—2N2712 transistor
The following resistors are ½-W carbon composition unless otherwise noted:
R1,R6—39,000 ohms
R2,R7,R14—1 megohm
R3,R4,R8,R9—100,000 ohms
R5,R16,R17,R21,R23—10,000 ohms
R10—3900 ohms
R11—5000-ohm panel-mount potentiometer
R12—5-megohm panel-mount potentiometer
R13—1000 ohms
R15,R20—150,000 ohms
R18—220 ohms
R19—3-megohm board-mount potentiometer
R22—47,000 ohms
R24,R25—2200 ohms
S1—Spst NO pushbutton switch



PARTS LIST
BELL

C1—0.05-µF capacitor
C2—0.01-µF capacitor
C3,C4—0.015-µF capacitor
C5—0.1-µF capacitor
C6,C8—0.047-µF capacitor
C7—100-µF, 25-V electrolytic capacitor
C9—22-µF, 25-V electrolytic capacitor
D1—Silicon diode rectifier
IC1—555 timer
Q1,Q2—2N2712 transistor
The following resistors are ½-W carbon composition unless otherwise noted:
R1,R3,R11—1 megohm
R2,R5,R6—82,000 ohms
R4—39,000 ohms
R7—100-ohm panel-mount potentiometer
R8—5000 ohms
R9,R12—1000 ohms
R10—33,000 ohms
R13,R15—10,000 ohms
R14—150 ohms
S1—Spst switch

Fig. 4. Bell circuit uses twin-T oscillator Q1 and switch.



PARTS LIST
MIXER

C1,C2,C3—0.47-µF capacitor
C4,C6—100-µF, 25-V electrolytic capacitor
C5—25-µF, 25-V electrolytic capacitor
J1 through J4—Phono connectors
Q1—HEPF0010 FET
Q2—2N2712 transistor
The following resistors are ½-W carbon composition unless otherwise noted:
R1,R2,R3—25,000-ohm board-mount potentiometer
R4,R5,R6—100,000 ohms
R7—10,000 ohms
R8—4700 ohms
R9,R10—1000 ohms
Misc.—Board, wire, solder, etc. for all four circuits.

Fig. 5. Sound effects are combined in Q1 and drive amplifier through Q2.

The output of *IC1* (pin 3) is applied to the voltage divider made up of *R13* and *R12* to reduce the signal level. The pulses are then rectified by *D1* and differentiated by *C8* and *R10* to produce sharp spikes that trigger the twin-T oscillator, *Q1*.

Mixer. The outputs of the three sound-effect circuits are combined in the circuit shown in Fig. 5. Each input is coupled to its own level potentiometer (*R1, R2,* or *R3*) and they are combined at the gate of FET *Q1*. The output of *Q1* is coupled to the external audio amplifier through emitter follower *Q2* and capacitor *C6*.

Construction. The easiest approach to construction of the synthesizer is to build each circuit on its own small board. You can use perforated board and point-to-point wiring or make a small pc board. The arrangement is not critical. Each board can be built and tested using a 15-volt supply and an earphone (or a small amplifier/speaker combination). Be sure that transients generated by the timer IC's are not coupled into any of the circuits. If necessary, more +15-volt line decoupling is recommended. Sockets can be used for the transistors and IC's.

In the prototype, short lengths of shielded audio cable were used to couple the output of the three sound-effect circuits to the mixer inputs. Another length of shielded audio cable connected the mixer output to the audio system being used.

The boards can be installed in any type of chassis, with all controls on the front panel, clearly identified.

Use. Connect the mixer output to a good-quality audio amplifier and speaker combination. In the bell circuit, set the threshold potentiometer (*R7*) for the best sound when bell switch *S1* is operated. There should be no clicks or pops. Do not try to control circuits by turning the power on and off.

The chuff-chuff has three front-panel controls with *R3* being the rate control, *S2* providing steam bursts, and *S1* for on-off. It is best to group these three controls together so that they can be operated with the fingers of one hand. The whistle circuit has one switch (*S1*); the three internal potentiometers in this circuit should be preset.

If your train system is already equipped with electronic speed controls, you might consider ganging the chuff-rate potentiometer with the train speed control potentiometer for smoother operation of the complete system. ◇

Solid State

By Lou Garner

ONE CIRCUIT/MANY GIFTS

WHETHER you celebrate Christmas, Chanukah, the Saturnalia, or the winter solstice, chances are you're now selecting gifts for your friends, relatives, and loved ones. Of all gifts, perhaps the nicest are those hand-crafted or assembled by the giver. They have that extra personal touch which is so much more meaningful than manufactured items purchased for a fistful of dollars at retail outlets.

itself that determines the nature of the final project, but the way in which it is modified and packaged for its intended application. A change here, a small modification there, a different case or cabinet, and you have a completely new gift. There are a number of designs which can be used, literally, in dozens of interesting gift projects by making relatively minor changes in the circuit or its housing.

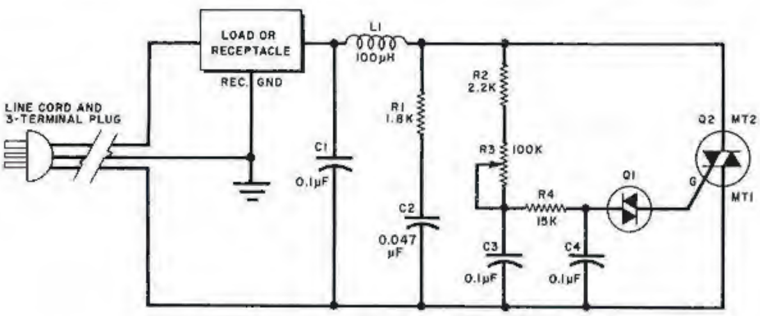


Fig. 1. This basic ac phase-control circuit can be used for a variety of useful and interesting gifts for friends and family during the holidays.

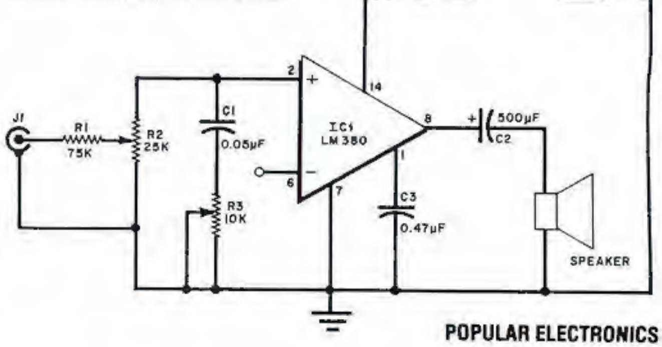
When choosing any gift, first make sure it is something the recipient can appreciate and use—a signal generator might make a dandy gift for a fellow hobbyist or technician, for example, but probably would be of little value to the average housewife, no matter how much care went into its assembly. Second, try to avoid the commonplace or routine—another AM transistor radio for a teen-ager who already has seven might be welcome, but may not be received enthusiastically. Third, make sure the item is safe and that accidental misuse can cause neither damage nor injury.

As an electronics hobbyist, you're fortunate in that you can easily assemble gifts to fit virtually everyone's needs and interests, from those of the housewife to the photographer, from the sports enthusiast and outdoorsperson to the student, and from the woodworker to the musician. The gifts may be assembled either from commercially available kits or from "scratch" using published circuit designs, depending on one's individual skills and budget limitations. If you're planning on a number of gifts and assembly from scratch, choose relatively simple proven designs using standard commercial components which, preferably, can be completed in one or two evenings or on a weekend. Elaborate projects, such as home computer systems and laboratory oscilloscopes may make welcome gifts, but you might have to start your project as early as June to complete it for the holiday season.

Add a dash of imagination to a blend of knowledge and skill and you'll find that you can use a single basic circuit for a variety of exciting and useful gifts. Quite often, it is not the circuit

A good example is the ac power control circuit illustrated in Fig. 1. Starting with this basic design, use an incandescent lamp socket for the output load device and add a spdt on-off switch in series with one side of the ac line. The switch may be ganged with control potentiometer *R3*, if preferred. The modified circuit can be used in assembling a variety of variable-intensity lamps, including both table and floor models in traditional as well as modern designs, all of which make excellent gifts for the home or office. Or you could use the circuit in designing and building a modernistic desk lamp for the business executive, student, teacher or office worker. On the other hand, if assembling complete lamps will require more time than you can spare or will tax your financial resources (lampshades *are* expensive), you could replace the lamp socket

Fig. 2. General-purpose audio amplifier circuit.



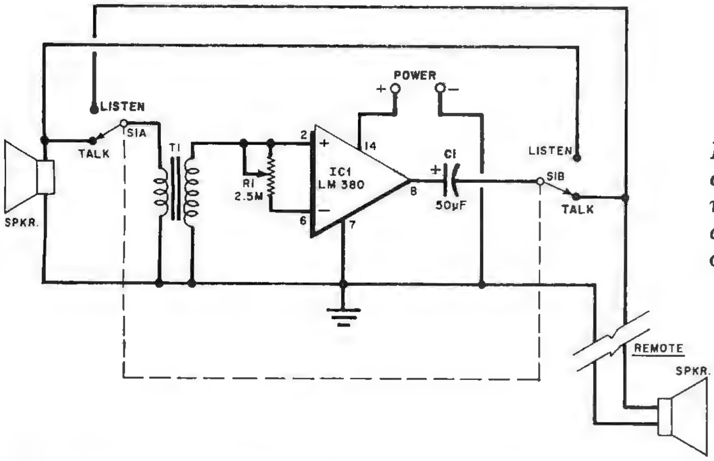


Fig. 3. An intercom based on the circuit originally shown in Fig. 1 makes a good gift for internal communications in most anybody's office or home, or around the workshop.

with a conventional line socket receptacle and assemble the circuit in a small wooden case as an "add-on" lamp dimmer for any existing incandescent lamp—another fine gift!

Perhaps you'd rather not throw a little light on the subject and are looking for something different. No problem! Using the same circuit, add a fuse holder in series with the switch in the power line, and use a line receptacle as the output element. Assemble the circuit in an insulated white enameled case with a white line cord and plug. Then add a dial for the control, install a pointer knob, and you have a variable-speed control for older kitchen appliances, such as blenders and mixers, and a lovely gift for your favorite cook. You could use the same design, but assemble it in a heavy duty gray *Minibox* and add a neon pilot lamp across the ac line as well as mounting holes or brackets. Then the unit becomes a variable-speed control for small power tools such as drills, sanders and jig saws . . . a terrific gift for woodworkers, repairmen, craftspersons and most other do-it-yourselfers. Assemble the same circuit in a blank sloping-front meter case and you have a versatile lamp control for your friendly neighborhood amateur photographer. He (or she) can use it with an enlarger, printer, or low-power floodlamps.

The suggestions outlined thus far are but a small sampling of the many gifts that can be assembled using one basic circuit. In addition, the same design could be used for a fan speed control (where the fan employs a series-wound universal motor) or as a sewing machine speed control to replace an old-fashioned power rheostat. Other possibilities include a heater control for fish tanks, small hot plates, hair dryers, chemical baths and soldering irons or pots. If, by chance, your

intended recipient is another electronics hobbyist, you can simply give him (or her) a kit of the necessary components and hardware, a copy of the circuit diagram, and a list of suggested applications, permitting him (or her) to have the fun of selecting and assembling a favorite project.

Referring to the schematic diagram, the circuit is a conventional phase-control design featuring two active semiconductor devices, a diac bi-directional diode, *Q1*, and a triac thyristor, *Q2*. In operation, *Q2* acts as a high-impedance device, blocking current flow through the external load until switched to a conducting state during each half cycle by a control voltage applied to its gate electrode through *Q1*. The point during each half cycle at which *Q2* is fired is determined by the relative phase relationship between the line and gate control voltages. This, in turn, is established by phase-shifting network *R2-R3-C3*. Adjusting *R3*'s value changes the phase relationship between the control and line voltages, firing *Q2* earlier or later during each half cycle. This permits a greater or lesser average current flow, effectively controlling the power delivered to the load. Snubber network *R1-C2* is included to reduce transient voltage peaks when the circuit is used with inductive loads such as motors and solenoids, while *L1* and *C1* form a simple r-f filter to reduce hash and noise levels.

With neither layout nor lead dress overly critical, the power control circuit can be assembled using any standard construction technique, including perf board, pc board, or point-to-point wiring on a metal chassis. A small heat sink should be provided for *Q2* if the circuit is to be used for controlling heavy loads, such as heaters and photographic flood lamps, but should not be needed for lighter duty applications. The snubber circuit, *R1-C2*, can be omitted if the circuit is used with resistive loads only; even the r-f filter, *L1-C1*, may be omitted for some applications. Except for linear potentiometer *R3*, all resistors are half-watt types, while the capacitors are 200-V plastic film or tubular paper types. The specified component values are for use with the *RCA* D3202U diac and T2500B triac, but only nominal value changes, if any, should be required for the use of other equivalent devices. Assembled in a standard TO-220 plastic package, the T2500B is a 6-A, 200-V silicon triac with a 60-A surge-current rating.

Though extremely versatile, the ac power control is by no means the only design adaptable to a wide variety of gift projects. Another example, a general-purpose, medium-power audio amplifier, is shown in Fig. 2. With a suitable IC, this circuit is capable of delivering up to several watts of output at relatively low distortion levels to 4-, 8-, or 16-ohm loads and, while accepting input signals as high as ±0.5 V, can offer a bandwidth of up to 100 kHz. It can be powered by either battery or well-filtered ac line-operated dc sources from 12 to 22 volts.

You can use the basic audio amplifier for assembling such worthwhile gifts as the following:

●Portable Phonograph—a fine gift for a youngster or teenager. Using a battery power pack, assemble the amplifier in an inexpensive attache case, adding a battery powered turntable and high-output crystal cartridge pickup. Install a spst toggle, slide or rotary switch in series with one of the phono motor leads. A second spst switch, ganged to either the *volume* (*R2*) or *tone* (*R3*) control, should be wired in series with the amplifier's positive dc lead. For operating convenience, a 12-volt dc source can be used as a power pack. In this case, the loudspeaker should have a 4-ohm voice coil. Use as large a PM loudspeaker as will fit conveniently within the available space for good sound reproduction.

●Signal Tracer—a nice gift for a technician or fellow hobby-

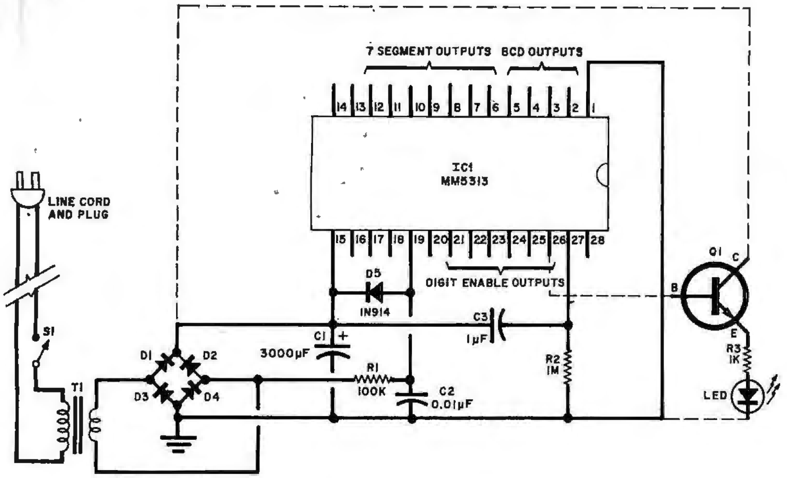


Fig. 4. Using an MM5313 clock chip, individual light emitting diodes can be driven by the BCD and 7-segment outputs to provide a multiple flasher that can be used for decorative lighting outdoors or indoors during the holidays.

ist. Assemble the amplifier in a portable test instrument case with integral power supply. An input jack (*J1*) is mounted on the front of the case and a separate spst toggle, slide or rotary power switch, wired in series with either the positive supply lead or the transformer's primary winding if an ac power pack is used. The tone-control circuit *R3-C1*, is optional. If desired, a pilot lamp may be added for an extra professional touch. Simply wire a standard LED across the amplifier's dc power input terminals in series with a resistor of appropriate value for the LED's rated current and the dc source voltage. Furnish shielded test cables with plugs to match *J1* and both dc blocking (series capacitor) audio and r-f detector probes.

●Auto Radio Remote Speaker—an interesting gift for campers, picnickers and outdoorspersons. Assemble the amplifier in a portable case or loudspeaker cabinet complete with battery power supply. Mount the input jack (*J1*) on the rear of the cabinet. Add a spst rotary power switch ganged to either the volume or tone controls. Install an output jack in parallel with the car radio's loudspeaker and provide a shielded cable terminated with plugs to match the two jacks.

●Music Instrument Amplifier—a terrific gift for the budding musician. It can be used for practice without rattling the windows. Assemble the amplifier system, controls, jack and power supply (or batteries) in a portable case or wall speaker cabinet, adding a separate power switch and pilot lamp as described in a previous paragraph. Provide an instrument microphone and length of shielded cable with a suitable plug to match the input jack.

(Continued on page 88)

●Power Megaphone—a fun gift for the sports enthusiast or amateur coach. Plan on using an external battery power pack to reduce weight, connected to the amplifier system proper through a length of line cord. Assemble the amplifier in a small *Minibox* mounted on the back of a trumpet loudspeaker. Omit the tone-control circuit (*R3-C1*) and substitute a 50-100-μF electrolytic capacitor for *C2* to emphasize voice frequencies. Omit *J1* and connect in its place a high-output crystal or dynamic microphone, cushioning it in a rubber mounting to minimize mechanical feedback. Add a pistol-grip handle and install a spst pushbutton power switch, wired in series with the positive dc supply lead.

●Intercom—a fine gift for the home, office or shop, this project requires additional modifications in the basic circuit, as shown in Fig. 3. The tone-control circuit has been omitted and the gain control (*R1*) circuit modified. A *Talk-Listen* switching system, *S1A/S1B*, has been added, together with an impedance matching input transformer, *T1*. The output coupling capacitor's size (*C1*) has been reduced to emphasize voice frequencies. As in the other projects, the dc source may be either batteries or a line-operated power supply. A separate spst toggle, slide or rotary power switch must be added, connected either in series with one of the battery leads or in series with the power transformer's primary winding, depending upon what type of power source is used. The use of a pilot lamp is optional. The "Master" (amplifier/speaker/power supply) and "Remote" (loudspeaker) units can be assembled in wooden, plastic or metal cases, as preferred, to suit the installation. Ordinary line cord or twisted pair intercom cable can be used for interconnecting the two units.

Although neither the parts placement nor wiring arrangement should be overly critical, good audio wiring practice should be followed when assembling any of the amplifier projects, with signal carrying leads kept short and direct and reasonable spacing provided between the input and output circuits. Regardless of the actual construction techniques employed—perf board, pc board, or chassis style—an adequate heat sink should be provided for *IC1*.

The lead connections identified in Figs. 2 and 3 are for a *National Semiconductor* type LM380, but other multiwatt audio amplifier IC's may be used in the various projects, provided correct lead connections are chosen and component values are adjusted for optimum performance. With the LM380, pins 3-4-5 and 10-11-12 should be soldered directly to the heat sink and circuit ground. If oscillation occurs under some loading conditions, a series network made up of a 2.7-ohm, 1/2-W, resistor and a 0.1-μF low-voltage ceramic capacitor should be connected between pin 8 and circuit ground. Referring to Fig. 2, *R1* is a half-watt resistor, *R2* and *R3* are audio-taper potentiometers, *C1* and *C3* are low-voltage ceramics, and *C2* is a 20-V electrolytic capacitor. In Fig. 3, *R1* is a audio-taper potentiometer, *C1* a 20-V electrolytic, and *T1* is a small step-up audio transformer with (approximately) a 25:1 ratio between the secondary and primary windings. Generally, 4-ohm loudspeakers are preferred with dc supplies up to 14 volts, while 8-ohm types offer better performance with amplifier sources from 16 to 22 volts. From an operational viewpoint, the loudspeaker sizes are not critical, but smaller units (2½" to 4") are better for the compact projects, such as the intercom and signal tracer, while the more efficient larger speakers (5" to 10") are preferred for the phonograph, instrument amplifier and remote speaker projects. As a general rule, too, the larger the loudspeaker, the better the low frequencies.

Reader's Circuit. Working with "hobby grade" digital clock

IC's and kits, reader Henry R. Bungay III, Professor of Chemical and Environmental Engineering at the *Rensselaer Polytechnic Institute* (Troy, NY 12181), found that these inexpensive devices could be used effectively as multiple LED flashers, with a single device capable of flashing from a dozen to as many as eighteen LED's in a pseudorandom pattern. Professor Bungay's technique is relatively simple and straightforward, as follows.

Using multiplexed clock IC's, the value of the timing capacitor in the multiplex oscillator circuit is increased to slow the scan speed to a visible rate. Then, individual LED's are substituted for the seven-segment readout elements, with the values of the output-current limiting resistors increased as required to compensate for the longer duty cycle. The resulting multiple flasher can be used for such applications as indoor decorative lighting (*ideal for the Holiday Season!*), as a conversation piece for a recreation or family room, as a stimulating display for advertising, or as a random pattern generator for games.

One of several possible circuit arrangements is illustrated in Fig. 4. Here, spst power switch *S1*, stepdown transformer *T1*, and full-wave bridge rectifier *D1-D4* constitute a conventional power supply, furnishing the 11-to-19-volt dc required for device operation. Capacitor *C1*, a 20-V electrolytic, serves as a simple ripple filter. All resistors are standard half-watt types; *C2* is a low-voltage ceramic capacitor, with a high-value metallized plastic film or tubular paper type used for timing capacitor *C3*. Diode *D5*, typically, is a type 1N914. The pin connections shown in the diagram are for the MM5313 clock chip (*IC1*) but, of course, other clock IC's can be used.

(Continued on page 151)

Experimenter's Corner

By Forrest M. Mims

READ/WRITE MEMORIES (RAM's), PART 1

LAST MONTH, we built a read-only memory (ROM) with some diodes and a BCD-to-deimal decoder. Now, we're going to experiment with the 7489 IC, a factory-produced read/write memory that can store sixteen 4-bit words.

As you know, ROM's store information without the need for electrical power and are called *non-volatile* memories. Most RAM's, on the other hand, are *volatile* memories; turn off the power and they forget whatever information is stored in them. You've probably seen read/write memories labeled RAM's *and* R/WM's. RAM, random access memory, is a fancy way of saying that any bit or word stored in the memory can be addressed as fast as any other. This contrasts with a *serial* memory like magnetic tape where a time-consuming search may be required to find a particular bit or word.

Since both ROM's and RAM's are random access memories, R/WM is a better label for the read/write memory than RAM. But "RAM" is pronounceable and R/WM isn't, so most people use RAM.

The 7489 RAM. The storage capacity of the 7489 is a far cry from that of the 4k (4,096 8-bit bytes) RAM's used by hobby computer enthusiasts, but the 7489 does have some interesting applications. It will help you understand some basic microprocessor terminology and operations.

Fig. 1. The 7489 RAM pin outline.

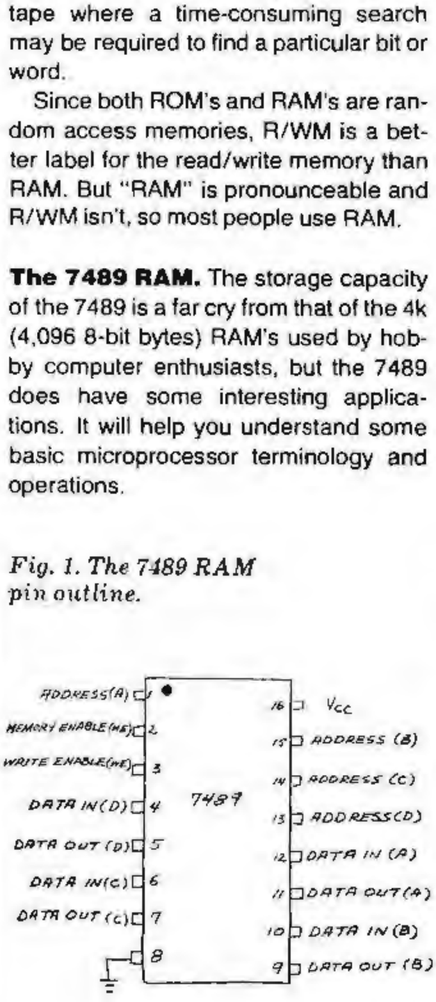


Figure 1 shows the pin diagram for the 7489. Here's a table that organizes the pins according to function:

Function	Pins D	C	B	A
Address lines	13	14	15	1
Data in	4	6	10	12
Data out	5	7	9	11

The 7489 also has a couple of *enable* inputs. The Memory Enable (ME) input, pin 2, is connected to ground (logic 0) during read and write operations. The Write Enable (WE) input, pin 3, must be at logic 0 when data is written into the RAM. Data can be read from the RAM when WE is at logic 1.

The 7489 has 16 storage slots designated by the addresses 0000-1111. Thanks to a built-in address decoder, writing a word into a memory slot is a simple matter of applying the appropriate BCD number to the address lines, placing both ME and WE at logic 0, and presenting the bits to be stored at the data input lines.

Reading a word from the RAM is even simpler. First, the word's storage slot address bits are applied to the address lines. Then ME is placed at logic 0 and WE at logic 1. The *complement* of the word in the selected address will then appear at the output.

Complementing a word means changing its 0's to 1's and its 1's to 0's. Thus, the complement of 1010 is 0101. This means you have to complement a word you want to store before writing it into the memory if you want it to appear in uncomplemented form at the output. In other words, if you want to retrieve 1100, store 0011 instead.

There are two points to keep in mind in using a 7489. First, it is a volatile memory, so you must keep power applied as long as you want to save the data stored in it. It's also a *non-destructive* memory. That is, the selected word is not lost when it's read out; it stays in the memory until replaced by a new word.

RAM Demonstration Circuit. You can learn a lot about RAM's by plugging the 7489 into a solderless breadboard along with some LED's to indicate the output data and jumper wires to select addresses and apply input data. Use the arrangement shown in Fig. 2. Take a few minutes to label each jumper with a marked square of masking tape. This will save lots of time later. Connect jumpers you want to be at logic 0 to ground and those at logic 1 to +5 volts. Try loading each storage slot with its binary address for practice.

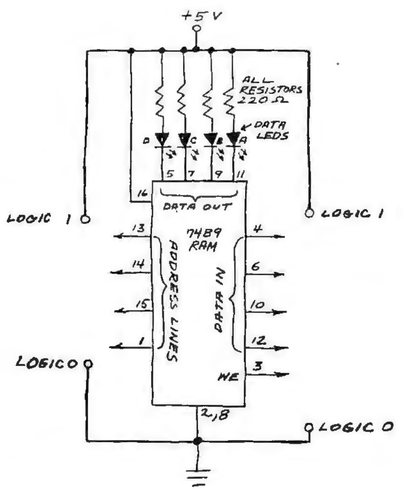


Fig. 2. A RAM demonstration circuit.

In this circuit a glowing LED indicates logic 0 and a dark LED, logic 1. You can automatically invert words stored in the memory by mentally assuming that a glowing LED signifies a logic 1. This means you don't have to load the complement of a word you want to save.

Automated RAM Demonstrator. A much better way to learn about RAM's as well as some microprocessor basics is to connect a binary counter to the address inputs of the 7489. Figure 3 is a block diagram that shows how everything goes together.

Here's how the circuit works using microprocessor terminology. Clock pulses enter the counter, and the 4-bit BCD count is applied to the address inputs of the RAM. The counter acts like a *pointer* as it sequentially selects first one address, then the next, and so forth.

In the READ mode (WE = 1; ME = 0), the data output LED's flash each word in succession as the pointer cycles through the memory. In the WRITE mode (WE and ME = 0), the LED's are extinguished, and the data on the input lines is written into the RAM. This means, of course, that the input data has to be

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changed between clock pulses or the pointer will load all the storage slots in the RAM with the same word.

The complete circuit for the automated demonstrator is shown in Fig. 4. It you form words to store in the RAM by simply flipping switches (much like a microcomputer designed for front-panel machine language program and data loading). Closing *S6* loads the word

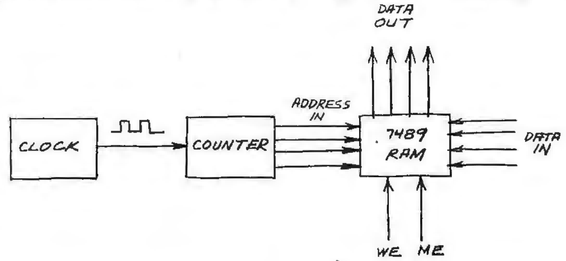


Fig. 3. Block diagram of automated RAM demonstrator.

makes a great fully programmable light flasher so you'll want to build it just to watch it flash.

The role of the clock is filled by a 555 timer, and a 7490 decade counter serves as the address pointer. The 7490 is a BCD counter so it recycles to 0000 after 1001 (decimal 9). This means it can address only ten of the 7489's storage slots. To address all 16 memory slots, you can use a full 4-bit counter (0000-1111) such as a 7493, 74161, or 74191. I've specified the 7490 because its operation has been covered previously here. It's also very inexpensive and readily available.

Notice the various switches and LED's in the circuit. Closing *S1* allows clock pulses to reach the counter. The CLOCK LED provides a handy visual indication that the clock is running and, below about 20 Hz, a rough idea of its rate.

The pointer LED indicates when the counter has recycled back to 0000. It's on when the count is 0000 through 0111 and off when the count is 1000 and 1001. This means the counter is pointing to address 0000 in the RAM the moment the pointer LED flashes on after being off for two pulses.

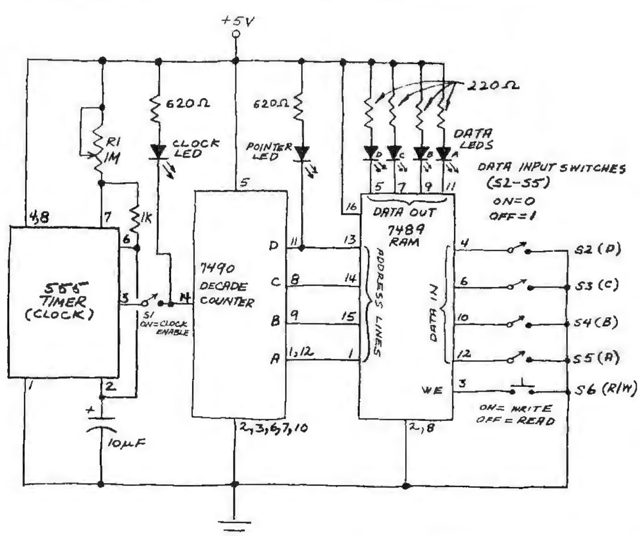
Toggle switches *S2* through *S5* let formed by the data input switches into the address slot selected by the pointer.

Of course, you don't have to use switches if you build the circuit on a solderless breadboard. Just remove and reinsert jumpers labeled with masking tape to simulate the on-off action of switches. Real switches, however, make the circuit much easier to use, particularly if you mount them on a small panel and identify them with labels.

Programming the automated RAM demonstrator is a straightforward procedure of loading words into the RAM one at a time until ten address slots are filled. Switch *S1* is turned off to disable the clock while a word is being loaded and turned on for one clock pulse to advance the pointer to the next address. It's easy when you slow the clock rate to about a pulse per second (by setting *R1* for maximum resistance) and keep an eye on the clock LED.

To Be Continued. Next month we'll discuss programming procedures in more detail. We'll also expand the demonstrator by adding an automatic pseudo-random data loader, and cover some ways to address all sixteen data storage slots in the 7489. ◇

Fig. 4. Automated Ram demonstrator.



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Product Test Reports

SPARKOMATIC MODEL CB 2040 CB AM MOBILE TRANSCEIVER

Touch tabs provide quick electronic setting of channels.

THE 40-channel Model CB 2040 AM transceiver from Sparkomatic has an angled panel for better viewing in mobile installations. It also has two touch tabs ("up" channel and "down" channel) for electronically setting up the channels, which replace the commonly used rotary channel selector switch. The transceiver is designed to operate from a nominal 13.8-volt dc, negative- or positive-ground, electrical source.

The Model CB 2040 employs digital frequency synthesis, using a phase-locked loop (PLL) as all 40-channel transceivers do. Features include: large numeric LED display for channel identification; r-f and audio gain controls; squelch control; individually switched automatic noise limiter (anl) and noise blanker; PA operation; external-speaker jacks; illuminated S/r-f meter; TRANSMIT and RECEIVE LED indicators; electronic voltage regulation; line filter; and reverse-polarity protection.

The transceiver measures 7.5"D × 6.6"W × 2.4"H (19 × 17 × 6 cm) and weighs 3.5 lb (1.6 kg). Supplied with detachable 500-ohm microphone and mobile-mounting hardware, the transceiver is priced at $159.95.

Technical Details. The receiver employs double conversion to i-f's of 10,695 and 455 kHz. The first conversion is made by heterodyning the CB signal with the voltage-controlled oscillator (vco) in the PLL system, which operates at a frequency 10,695 kHz higher than the signal frequency. The second conversion is made with a 10,240-kHz crystal oscillator signal. The standard 10-kHz reference signal is obtained from this oscillator and dividers. The vco signal is also mixed down, using a 36,380-kHz crystal signal and then divided according to the channel selected to provide the 10-kHz comparison signal.

Except for the FET-type first mixer, bipolar transistors are used throughout the transceiver. The gain of the receiver is controlled by varying the emitter bias of the r-f input stage. Bandpass coupling is used between the input and output of the two mixers.

Selectivity is obtained with a 455-kHz ceramic filter. The filter is followed by two i-f stages, the detector, and the agc and anl systems. An audio amplifier and a driver stage precede the audio power output stage that uses a transformer-coupled class-B push-pull design.

The noise blanker employs two r-f noise amplifiers, a detector, and a pulse amplifier. The pulse amplifier gates the output of the second mixer through a balanced dual-diode scheme.

The transmitter carrier is generated by difference-mixing the output of the vco with a 10,695-kHz crystal signal. An r-f amplifier is then used for amplification, while a three-section band-pass filter attenuates unwanted spurious responses. Next come a predriver, driver, and the power amplifier stage. The output circuit for the power amplifier has a four-section low-pass filter that matches to 50-ohm loads and minimizes spurious output signals, especially the signals that can cause TVI. The reduction of TVI is further improved by use of a trap.

The receiver antenna input is taken from the power amplifier end of the antenna filter. Hence, input signals above 28 MHz are highly attenuated, improving the image and other unwanted-signal rejection at the upper frequencies.

An IC microphone preamplifier feeds the audio driver of the receiver's audio section, which then modulates the collectors of the transmitter driver and power-amplifier stages. Automatic modulation control is provided by a feedback compression-type system.

Laboratory Measurements. We measured a receiver sensitivity of 0.5 μV for 10 dB (S + N)/N at 1000 Hz and 30% modulation, bettering manufacturer's claim of 0.7 μV and 1 μV. The squelch threshold range was 0.3 to 10,000 μV. The agc held the audio output to within 10 dB with a 20-dB input signal change at 1 to 10 μV and to 15 dB with an 80-dB input change at 1 to 10,000 μV. The meter registered S1 with a 0.5-μV input signal and S9 with a 100-μV signal.

Adjacent-channel rejection and desensitization was nominally 55 dB, as against a −50-dB specification. I-f rejection was −60 dB, while image rejection was −80 dB (versus −55 dB spec) and other unwanted-signal rejection was down a minimum of −50 dB. Overall 6-dB a-f response was 375-1700 Hz and the maximum sine-wave output (both on receive and for PA) at start of clipping was 3 watts at 2.2% THD with 1000 Hz into 8 ohms.

Operating the transceiver from the standard 13.8-volt dc power source, we measured a transmitter output of 3.5 watts. With microphone input levels 16 to 25 dB greater than required for 50% modulation, the modulating level held to just short of 100% using a 1000-Hz test tone. Adjacent-channel splatter under this condition (or with a 2500-Hz test signal) was 50 to 55 dB down. Splatter with voice signals was 55 dB down.

The 6-dB down audio response was 400 to 1700 Hz (+1 dB at 700 Hz). Maximum attainable modulation was only 50% at frequencies beyond 2000 Hz. The transmitter frequency on any channel was within ±10 Hz of −160 Hz.

User comment. The transceiver is all black with gray control knobs and channel selector touch tabs. Its panel is angled back slightly, but not really enough to make a significant improvement in viewing. On the other hand, white lettering on the black background does make identification of the controls much easier than is usually the case in mobile transceivers.

Rotary controls are used for adjusting the volume, r-f gain, and squelch, while

miniature toggle switches are used for switching in and out the anl and noise blanker and selecting between CB and PA operation. An edgewise meter sits behind a window that also frames the LED numeric channel display. (The numerals extinguish in the PA mode.)

The touch tabs are located on the right side of the panel. The upper tab is used for cycling through the channels in the upward direction, the lower tab for cycling in the downward direction. In addition, an arrow on each tab indicates the cycling direction. Channels can be manually stepped in either direction or automatically scanned, depending on whether the tabs are touched and released or held depressed. It takes about a second before the automatic scan function begins, after which it scans at a fairly fast rate. Channels cannot be changed while the transmitter is keyed. When the transceiver is first turned on, it automatically goes to Channel 9.

The mode LED indications glow nicely under all lighting conditions. A green LED is used on receive, while a red LED comes on in the transmit mode. The transmit LED also blinks in step with the modulation.

Plenty of audio gain is available from this transceiver. In fact, just by cracking open the volume control, a good output level is obtained. However, the setting of the volume control is a bit touchy with a sudden change in volume occuring at the most used level.

As usual, the r-f gain control is handy for minimizing overloading by strong signals. With this transceiver, the most notable condition when overloading can occur is in cases where a very strong signal appears about 20 channels above the desired channel. For example, if you are listening to a 1-μV signal, a 300-μV signal on a higher channel frequency can also appear as a 1-μV signal on the tuned channel. This condition is fairly common in PLL-controlled receivers.

As noted above, the audio response on both receive and transmit drops off beyond 1700 Hz. In fact, on transmit, it drops off fairly fast beyond 1000 Hz. We would like to see a higher upper-frequency response for crisper quality.

The transmitter's amc system operates very well. It held down overmodulation and splatter while maintaining full modulation at speaking distances ranging from 1" to 8" (2.5 to 20.3 cm) from the microphone.

Tests with two different impulse-noise generators, an electric razor, and ignition noise in a vehicle proved that the anl was quite effective. It was interesting to note that, in many cases, even with weak signals, ignition noise virtually disappeared whenever a signal appeared. This made use of the anl seldom necessary, except to drop the residual noise, while searching for a signal.

We found no usefulness in switching in the noise blanker, since it had little apparent effect on the noise. In our experience, noise blankers have never been very effective in handling noise problems with AM reception. In cases where an anl and a noise blanker are switched in simultaneously, it is primarily the automatic noise limiting that is the effective noise-reducing element.

This transceiver has no clarifier or Delta tune mechanism, which we have in the past emphasized as being an unnecessary gimmick for AM. It is even more useless with interstation operation in the new 40-channel phase-locked-loop transceivers, since they generally hold the frequency tolerance within better than 200 Hz.

All in all, we find this Sparkomatic transceiver to be very good. It should provide the CB'er with convenience and long service.

CIRCLE NO. 104 ON FREE INFORMATION CARD

SABTRONICS MODEL 2000 DIGITAL MULTIMETER KIT

Low-price, 3½-digit multimeter kit features high-quality components.

THE Sabtronics Model 2000 is perhaps the lowest priced digital multimeter on the market to offer a full 3½ digits of display and five functions. Priced at only $69.95, this instrument can be used to measure ac and dc voltage and current and resistance. It is available only in kit form.

To keep costs down, the basic Model 2000 comes without test leads and has provisions for only battery operation—using standard carbon-zinc or high-energy alkaline cells. Available as separate options are a test-cable kit ($3.50), an ac power supply/battery charger ($10.90), and a sub-C nickel-cadmium battery pack ($12.95).

The DMMM measure 8"W × 6.6"D × 3"H(20.3 × 16.5 × 7.6 cm).

Technical Details. The Model 2000 DMM features a full 3½-decade red LED display, automatic zeroing and polarity indication on all ranges, and battery operation for portability. (Ac operation is possible with an optional battery eliminator that doubles as a charger when nickel-cadmium cells are installed.) A total of 28 ranges is provided, and all function/range selection is performed with pushbutton switches.

Five dc-voltage ranges are provided: 100 mV, 1000 mV (1 volt), 10 volts, 100 volts, and 1000 volts. With the instrument's overrange capability, the display can indicate up to 199.9 mV, 1999 mV, 19.99 volts, 199.9 volts, and 1000 volts. Resolution is rated at 100 μV, 1 mV, 10 mV, 100 mV, and 1 volt, respectively. The rated accuracy is 0.1% ± digit on the 100- and 1000-mV ranges, 0.1% ±2 digits on the 10-volt range, 0.2% ±2 digits on the 100-volt range, and 0.5% ±2 digits on the 1000-volt range. Input protection to 1000 volts dc or 1400 volts ac is provided on all ranges. Input resistance is rated at 10 megohms on all ranges, while response time is specified at 500 ms typical.

The ac-voltage ranges are the same as in the dc mode (100 mV, 1000 mV, 10 volts, 100 volts, and 1000 volts). The overrange, resolution, and input protection are also the same. The respective accuracies (at 60 Hz) and frequency responses on the ranges are 0.3% ±2 digits, 40 Hz to 50 kHz; 0.3% ±1 digit, 40

Hz to 50 kHz; 0.3% ±2 digits, 40 Hz to 20 kHz; 1.0% ±1 digit, 40 to 2000 Hz; and 1.0% ± digits, 40 to 500 Hz. Impedance on all ranges is specified at 10 megohms shunted by 25 pF, while maximum response time is stated at 5 seconds to five digits of reading.

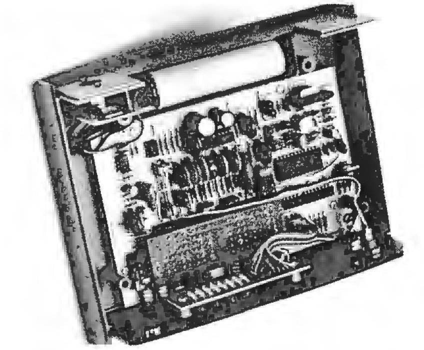


Photo shows neat insides of meter.

The ac and dc current ranges are the same: 10 μA, 100 μA, 1 mA, 10mA, 100 mA, and 1000 mA (1 ampere) full-scale. With overrange, the instrument can display currents to 19.99 μA, 199.9 μA, 1.999 mA, 19.99mA, 199.9 mA, and 1999 mA. The respective resolution on both ac and dc is 10 nA, 100 nA, 1 μA, 10 μA, 100 μA, and 1 mA. Dc accuracy on the three lower ranges is 0.1% ±2 digits and on the other ranges 0.1% ±1 digit. The ac accuracy is 1.0% ±5 digits on the 10-μA range, 0.1% ±2 digits on the 100-μA and 1-mA ranges, 0.1% ±1 digit on the 10-mA range, and 0.8% ±2 digits on the 100-mA and 1000-mA ranges. The ac frequency range is 40 Hz to 500 kHz on the 10- and 100-μA ranges, 40 Hz to 20 kHz on the other ranges. The ac and dc input impedance is 1 ohm on the 100- and 1000-mA ranges, 100 ohms on the 1- and 10-mA ranges, and 10,000 ohms on the 10- and 100-μA ranges. All input ranges in both modes are fuse protected to 2 amperes.

The resistance ranges go to 100 ohms, 1000 ohms, 10 kilohms, 100 kilohms, 1 megohm, and 10 megohms full-scale. With overrange, the display indicates up to 199.9 ohms, 1999 ohms, 19.99 kilohms, 199.9 kilohms 1.999 megohms, and 19.99 megohms, respectively. Resolution on the successive ranges is 0.1, 1, 10, 100, 1000, and 10,000 ohms. Accuracy is rated at 0.1% ±1 digit for the four lowest ranges, 0.2% ±2 digits for the 1-megohm range, and 0.5% ±5 digits for the 10-megohm range. Measuring current is rated at 1 mA for the 100- and 1000-ohm ranges, 10 μA for the 10- and 100-kilohm ranges, and 100 nA for the 1- and 10-megohm ranges. The voltage at the test probes is 100 mV on the 100-ohm, 10-

Stanton joins the New York Jazz Museum in preserving a musical heritage:

The message in the letter was clear: "Many of our recordings are rare or long out-of-print. The music that is preserved in our Archives must be made available to the Museum's visitors in order to enhance their appreciation of our exhibits. However, these recordings must be properly preserved during playback and that is why I am writing to you."

So, along with its Archives of over 25,000 items, including photographs, books, pamphlets, magazines, films, musical instruments, art, memorabilia and over 4,000 record albums and 78 rpm recordings — the New York Jazz Museum now has Stanton equipment to help it fully serve its function. The Calibrated Stanton 681 Triple E cartridge is, of course, a prominent component of that system.

So, their sure-to-improve sound is certain to have favorable impact on their growing audience.

Stanton's 681 Triple E cartridge offers improved tracking at all frequencies, and achieves perfectly flat frequency response to beyond 20 kc.

Each 681 Series cartridge is guaranteed to meet its specifications within exacting limits, and each one boasts the most meaningful warranty. An individually calibrated test result is packed with each unit.

For further information write to:
Stanton Magnetics
Terminal Drive
Plainview, N. Y. 11803

STANTON

kilohm, and 1-megohm ranges and 1 volt on all other ranges. The input is protected by a 2-ampere fuse to 250 volts dc and rms ac.

Power for the DMM can be any 4-to-6.5-volt dc, 120-mA source. The instrument is designed to provide 25 hours of operating time on four C-size alkaline cells, up to 15 hours on four C-size nickel-cadmium cells.

General Details. This is a well-thought-out kit, from packaging to final assembly and calibration. All components are packaged in compartmented polybags for easy viewing and identification. Both the main and display printed circuit boards are silk-screened with component locations and orientations to simplify assembly and help reduce installation errors. The only components that mount off the boards are the input test jacks and the battery supply. (If the optional ac power supply/battery charger is used, its circuitry goes on a small board that mounts to a rear panel of the instrument's case.)

Assembling the DMM is a very simple procedure, thanks mainly to a fine assembly manual and the planning that virtually eliminates point-to-point wiring. To this end, Sabtronics even supplies an auxiliary pc board that goes on top of the nine-bank function/range switching array to interconnect the appropriate lugs and eliminate all possibility of wiring errors here. (This auxiliary board can be installed only one way.)

As we assembled the kit, we noted that, even though the kit price is very low, there was no skimping on the quality of the components used. All resistors, for example, had tolerances of either 5% or 1%, even in places where 10% or even 20% tolerances could have been used. The other components were of commercial-grade quality.

Working at a leisurely pace, it took us less than five hours to assemble, check out, and calibrate the DMM. We noted only one small area where assembly could have been a bit difficult—a battery of resistors with 1% tolerances and color-coding that's not easy to read. Fortunately, Sabtronics has anticipated this problem and supplies an easy-to-interpret slip of paper that explains the coding in full detail. Otherwise, the entire assembly procedure was so simple and straight-forward that we feel even a neophyte could handle the job easily.

After assembling the DMM, we performed the "without-instruments" calibration procedure detailed in the assembly manual. This procedure makes use of the voltage and resistance calibration standards assembled into the meter. When this was done, we used a voltage standard and high-tolerance resistors to determine the accuracy of the calibration. In all cases, the calibration accuracy was almost as good as we later obtained with the "instrument-calibration" procedure. It certainly displayed all the accuracy needed for hobbyist/experimenter/servicing applications.

The assembled instrument has a clean, modernistic look about it. It has no rotary controls, just a battery of nine color-coded switches. The POWER switch is red, the FUNCTION switches are gray, and the RANGE switches are off-white. To the right of the switches are a red VΩ A and a black COM input test jacks. Located above the bank of push-button switches are the 3½ decades of LED display. (This is actually a full 4-digit display with only the *a* and *b* segments used to display a numeral 1 and the *g* segment used to display a – sign when dc voltages and currents are being measured.)

Built into the proprietary blue plastic case that houses the instrument are a pair of rails that serve as "feet" for the DMM. They also double as a retaining system for the wire bail that can be pulled down and locked into place to allow the instrument to tilt upward for more convenient viewing in lower-than-eye-level locations.

Operation of the DMM is very simple. After plugging in the test leads one simply presses in the POWER, desired FUNCTION, and desired RANGE switches. (There are four RANGE switches, three of which select a given range directly while the fourth is for selecting the next higher decade range for a given activated range.) Then all one does is touch the probes to the appropriate points in the circuit under test and reads out the value of the display.

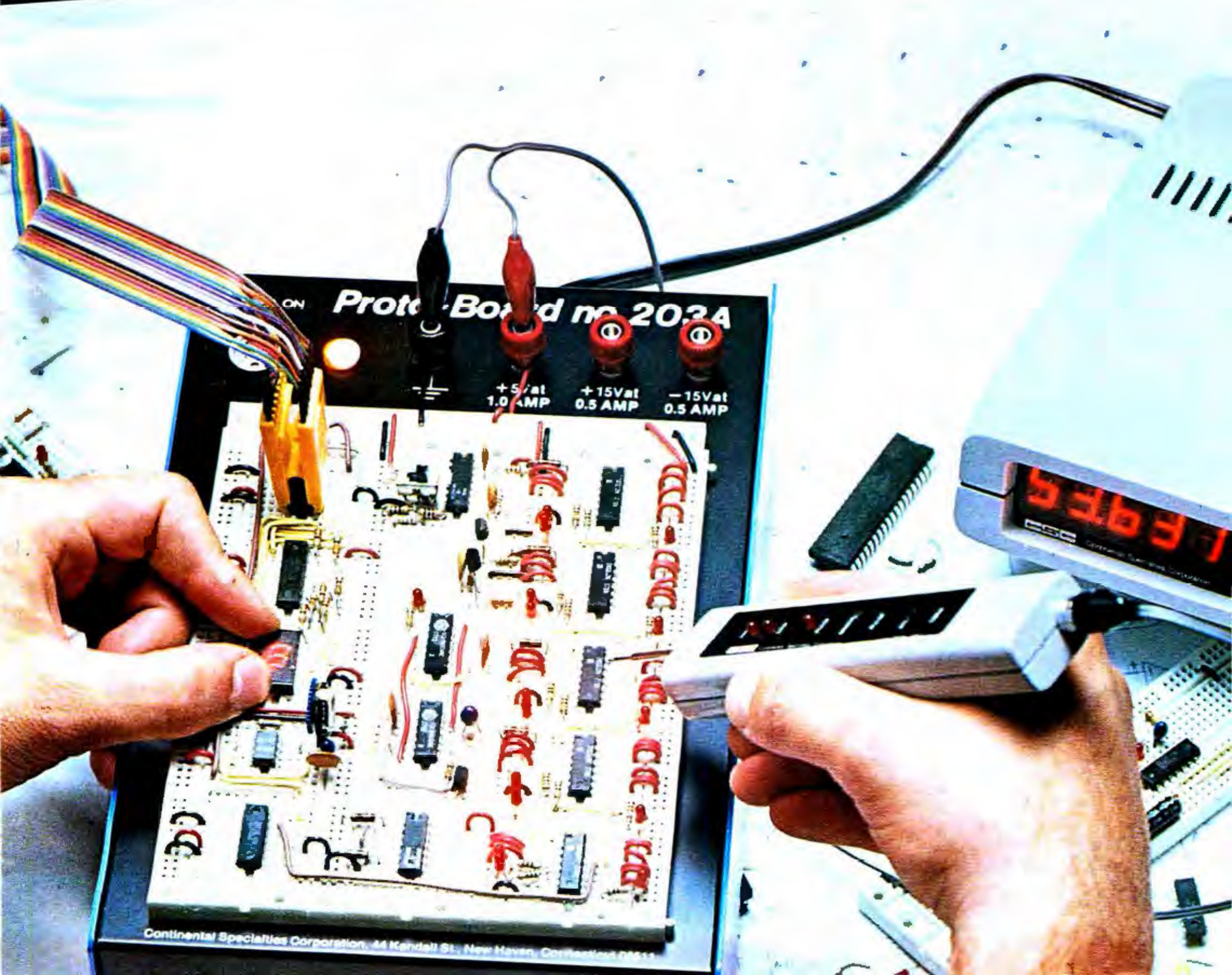
User Comment. In our opinion, the Sabtronics Model 2000 DMM gives the buyer top value for his investment. It is a basic digital multimeter that is designed to deliver a level of performance available heretofore only in more expensive instruments. Though it comes without test leads, batteries, and ac power supply/battery charger (all available optionally), it gives a full complement of most-wanted functions, ranges, and features—all at a price directly competitive with analog instruments that do not provide anywhere near the same measuring accuracy.

CIRCLE NO. 105 ON FREE INFORMATION CARD

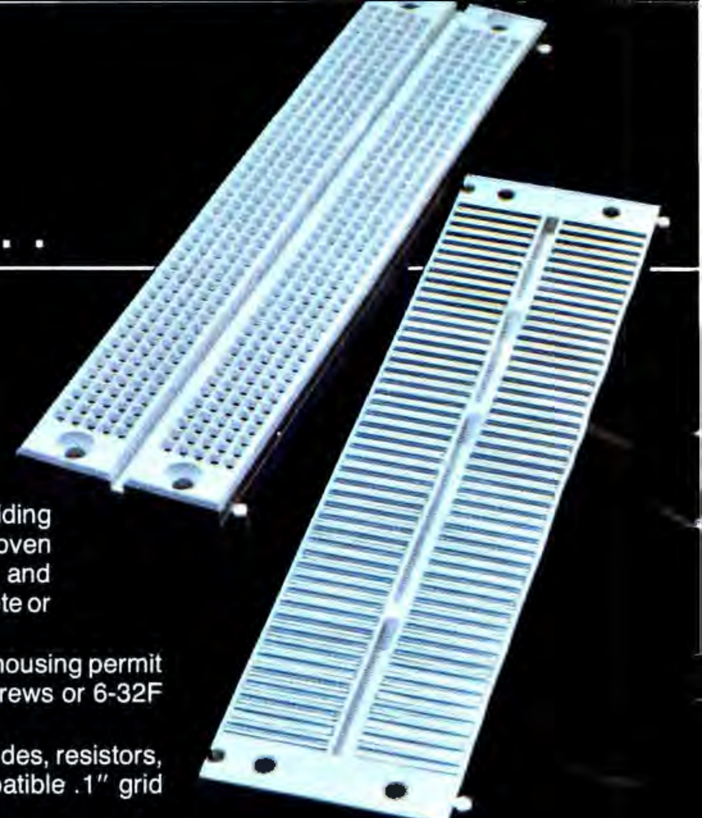
BREADBOARDING & TEST EQUIPMENT

THE COMPLETE, LOGICAL, STEP-BY-STEP SOLDERLESS SOURCE . . .

CONTINENTAL SPECIALTIES CORPORATION



Create circuits as fast as you can think. Start with The Basics . . .



QUICK TEST SOCKETS*

Imagine! Non-stop wiring, testing, modifying and building . . . all without patch cords or solder! Fast, reliable proven CSC Quick Test Sockets let you work out new ideas and reactivate old ones, without a worry over harming discrete or IC components . . . or your fingers.

EASY MOUNTING. Molded-in mounting holes in the housing permit top mounting to any flat surface with 4-40 flat head screws or 6-32F self-tapping screws for behind-the-panel mounting.

ACCEPTS ALL STANDARD COMPONENTS. ICs, diodes, resistors, capacitors, transistors, etc. All plug into the DIP compatible .1″ grid without messy, troublesome solder.

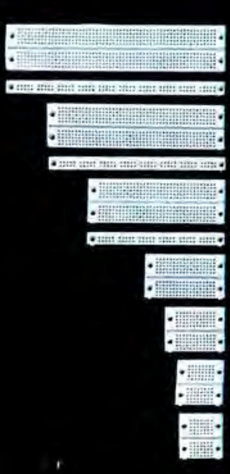
HOOK UP. Connect power and ground leads to your bus strip. Plug in your ICs and discretes. Then interconnect with a #22 solid wire. Connect a signal source to bus strip or directly to input point of your circuit. Each socket has **5 tie points per terminal**. Each bus strip has **2 separate rows of interconnecting terminals**. Turn on the power and signal source. Hook-up a scope probe, counter, etc. Then, if you have to add additional wire, need another IC or component — just plug them in.

INTERCONNECTIONS. Each terminal has 5 connected solderless tie points formed from a prestressed, spring loaded non-corrosive alloy to insure secure mechanical and low resistance electrical connections. All sockets are 1.32″ wide. All bus strips are .36″ wide. All sockets and bus strips are .33″ thick. And, all are perfect for high temp jobs up to 100°C.

EASY. That's the hallmark of CSC Quick Test Sockets. **INEXPENSIVE.** It goes without saying. **STANDARD FOR THE INDUSTRY.** Need we say more?

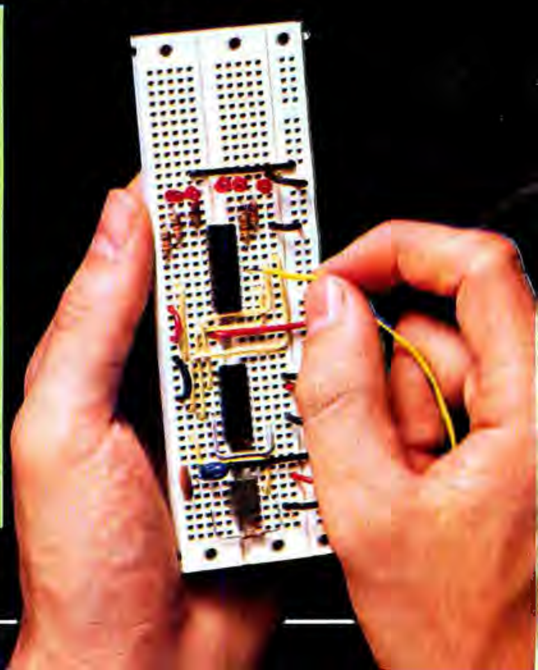
Exclusive SNAP/LOCK design breadboarding system allows you to expand or contract your work by snapping together as many Quick Test sockets or bus strips as you need, when you need them.

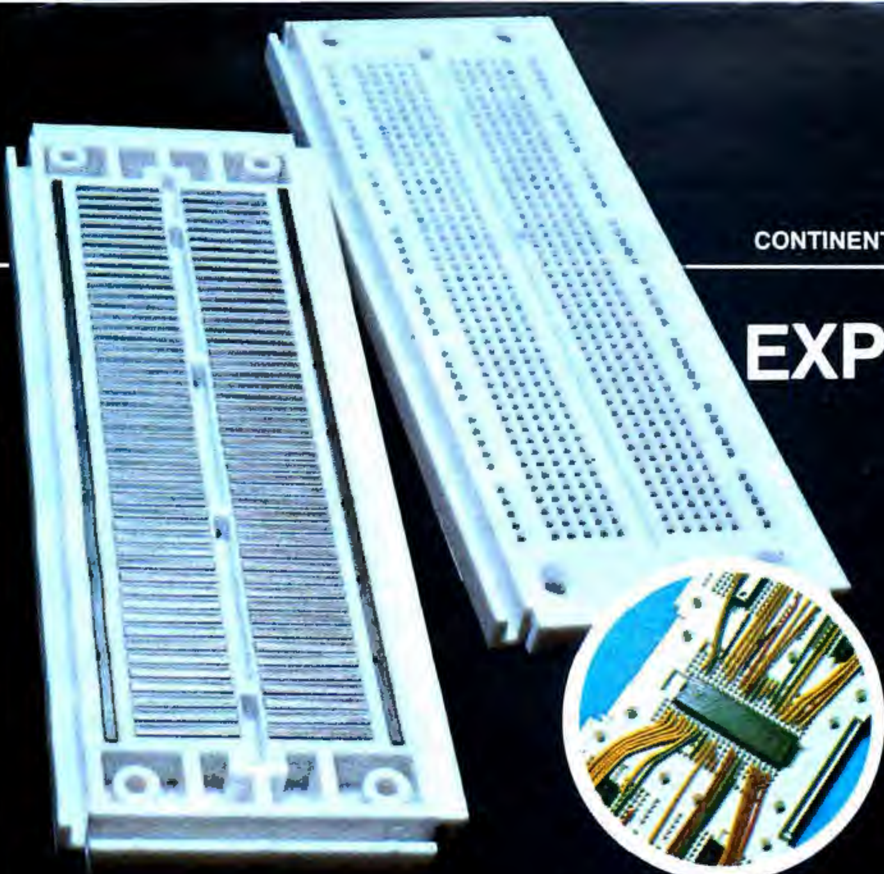
ORDER YOUR QT SOCKETS AND BUS STRIPS TODAY! CONTACT YOUR LOCAL DISTRIBUTOR OR USE THE HANDY ORDER FORM ON THE BACK PAGE!



	Length	Hole-to-hole	Terminals	Unit Price $
QT-59S	6.5″	6.2″	118	12.50
QT-59B	6.5″	6.2″	20	2.50
QT-47S	5.3″	5.0″	94	10.00
QT-47B	5.3″	5.0″	16	2.25
QT-35S	4.1″	3.8″	70	8.50
QT-35B	4.1″	3.8″	12	2.00
QT-18S	2.4″	2.1″	36	4.75
QT-12S	1.8″	1.5″	24	3.75
QT-8S	1.4″	1.1″	16	3.25
QT-7S	1.3″	1.0″	14	3.00

*U.S. Patent Design No. 235,554





CONTINENTAL SPECIALTIES CORPORATION

EXPERIMENTOR T.M. SOCKETS

Introducing the Domino Theory of Breadboarding. Snap them together vertically or horizontally with a choice of .6″ or .3″ centers. When your breadboard becomes overcrowded, just snap on another . . . vertically or horizontally . . . and keep on trucking. Just like dominoes, you keep going and going in any direction, until your idea is completed.

You can interface in any direction, horizontally or vertically, just like dominoes. Keep on trucking.

EXPERIMENTOR 300*. 550 individual solderless tie-points with .3″ center for smaller DIPs. The ideal mate for peripheral microprocessor ICs . . . without soldering. Each 6″ x 2″ x ⅜″ board has 47 horizontal dual rows of five interconnected terminals. Plus, a 40 point bus strip along each edge. Best of all, simple interlocking rails let you keep on building as your ideas pour out. **Order your EXPERIMENTOR 300 today. Only $9.95.**

EXPERIMENTOR 600*. Just like the EXPERIMENTOR 300, with one **small** difference. You can get into microprocessors with the ease of a .6″ center to snap-in LSI chips . . . plan, design, implement your own programs. Now you can actually build your own minicomputer . . . and keep adding as you go. Need more space? Just connect another EXPERIMENTOR 600 and interface. **Hurry! Order your EXPERIMENTOR today! Only $10.95.**

To connect, simply "handshake" any of four lugs with a matching slot on any other EXPERIMENTOR . . . in seconds.

EXPERIMENTOR 350*. Two rows of 46 five-point terminals, plus two 20-point bus strips. .3″ centers. ⅜″ x 3½″ x 2″. A must! **Order today! Only $5.50.**

EXPERIMENTOR 650*. Two rows of 46 five-point terminals, plus two 20-point bus strips on .6″ centers. ⅜″ x 3½″ x 2¼″. You shouldn't be without one . . . or two. **Only $6.25.**

EXPERIMENTOR QUAD BUS STRIP.* Flexible with four 40-point bus strips. ⅜″ x 6″ x ¾″. Essential and economical. **Order yours now! Only $4.00.**

ORDER YOUR EXPERIMENTORS TODAY! CONTACT YOUR LOCAL DISTRIBUTOR OR USE THE HANDY ORDER FORM ON BACK PAGE!

Model	Length	Width	Center Channel	5 Tie Point Terminals	Bus Strips	Price
EXP300	6.0″	2.1″	.3″	94(470)	2(80)	$ 9.95
EXP350	3.6″	2.1″	.3″	46(230)	2(40)	$ 5.50
EXP600	6.0″	2.4″	.6″	94(470)	2(80)	$10.95
EXP650	3.6″	2.4″	.6″	46(230)	2(40)	$ 6.25
EXP4B	6.0″	1.0″	n/a	n/a	4(160)	$ 4.00

Vinyl insulated backing permits mounting anywhere without shorting. Molded-in mounting holes permit mounting to any flat surface with 4-40 flat head screws or 6-32F self tapping screws for behind-the-panel mounting.

*U.S. Patent Number 235,554

Expand your thinking! Intensify your creativity! Full-service PROTO-BOARD Breadboards . . . from kits to built-in power supplies.

PROTO-BOARD® BREADBOARDS

Here are six simple, complete total breadboards . . . everything from easy-to-assemble kits to powerhouse regulated power supplies. We've combined the best of the QT Sockets and Bus Strips into easy-to-use, table top, expanded breadboards. Forget soldering. All you need is solid #22 AWG wire for interconnections. Aluminum baseplates on larger models are perfect, solid, ground plane work surfaces. Rubber feet won't scratch. 5-way binding posts for simple tie-ins. And, every Proto-Board is compatible with digital or linear ICs in TO5s, DIP packs and discrete components. So, if you're into kits, we've got two low cost models for you. Or, if you want to start building immediately, look into one of CSC's ready-made ProtoBoard breadboards. And just look at those prices! Very reasonable, considering all you get.

PROTO-BOARD 203

- The breadboard with built-in 1% regulated 5VDC, 1 amp supply 2,250 solderless tie points .24 14-pin DIP capacity which also accepts larger and small IC's up to 40-pin.

So you want ZIP with your ZAP! Have we got a power breadboard tester for you! Just plug in the PB-203 and let your powerful ideas run their course. You've got 2 extra floating 5-way binding posts for external signals. Self-contained power switch, indicator lamp and power fuse . . . plus 24 14-pin DIP capacity. The mighty built-in, regulated power supply is short-proof with 5VDC, 1 amp. It puts out 5V ± .25V, with 10 millivolts ripple and noise at .5 amp. And, the load regulation is better than 1%. Now that's power! That's capacity! That's flexibility! That's something else! THAT'S THE PB-203! And, it's all yours, in one power-packed package for only $80.00. Size? Short and light. 9.75" long x 6.6" wide x 3.25" high (248 x 168 x 83mm) and it weighs a mere 5.5 lbs. (2.26kg). Plug-in. Turn-on. Order your PB-203 NOW! **$80.00**

PROTO-BOARD 203A

- Just like the PB-203 . . . and then some! • 1% regulated 5VDC supply
- Regulated separate +15VDC and −15VDC .5A supplies, each with internally, independently adjustable output voltage (7-18V)
- Ripple and noise of + and −15V supplies, 10mV at 0.25A

You say you haven't had enough? You say you want **more** power? You say you want more flexibility! Tell you what we're gonna do! We're going to offer you the dynamic PB-203A. It's the big brother of PB-203. All the specs are the same, but just look at the separate regulated supplies of +15VDC and −15VDC, 0.5A, each with its own internal, independent adjustable output voltage! If you really want to turn on . . . order your PB-203A . . . NOW! **$129.95**

ORDER YOUR PROTO-BOARD BREADBOARDS TODAY! CHECK WITH YOUR LOCAL DISTRIBUTOR OR USE THE HANDY ORDER FORM ON THE BACK PAGE!

PROTO-BOARD 6
The lowest priced solderless breadboarding kit made today. Completely packaged. Assembles in minutes. Start designing in seconds. Flexible 6 14-pin DIP capacity (also accepts larger and smaller IC's up to 40 pin). 630 tie points, less than 2.5¢ each. **And for only $15.95.**

PROTO-BOARD 100
Mini-Kit
Assembles in seconds. Ten 14-pin IC capacity and mini-price. 760 tie points. Under 2.7¢ each (also accepts larger and smaller IC's up to 40 pin). **Just $19.95.**

PROTO-BOARD 101
For the "tight fisted" experimenter. Ten 14-pin DIP's (also accepts larger and smaller IC's up to 40 pin). 940 tie points, under 3.2¢ each. 8 distribution buses; 2 horizontal, 6 vertical, 30 contacts each. **Only $29.95.**

PROTO-BOARD 102
For champagne experimenters on beer budgets. 1,240 solderless tie points, under 3.2¢ each. Twelve 14-pin DIPs (which also accepts larger and smaller IC's up to 40-pin). Only you know how little you spent. **$39.95**

PROTO-BOARD 103
For you tight-fisted designers. Modest price. 2,250 solderless tie points (under 2.7¢ each). 10 distribution buses (2 horizontal w. 40 contacts ea.; 8 vertical with 50 each. Also accepts larger and smaller IC's up to 40 pin). **$59.95**

PROTO-BOARD 104
Here's a lollapalooza! 3,060 tie points. Four 5-way binding posts, one grounded. 32 14-pin DIPS (also accepts larger and smaller IC's up to 40 pin). 14 distribution buses. Everything you need. Affordable too. **$79.95**

U.S. Patent Design No. 241.252

Model Number	L x W x H (Inches)	Tie Points	IC Capacity (14-Pin DIPs)	No. of Sockets	Type	No. 5-Way Binding Posts	Wght. (Oz.)	Price	Other Features
PB-6	6.0x4.5x1.4	630	6	2 1	QT-47B QT-47S	4	7.0	$15.95	Kit. Assembles in minutes.
PB-100	6.0x4.5x1.4	760	10	2 1	QT-35S QT-35B	2	7.5	$19.95	Kit with larger capacity
PB-101	6.0x4.5x1.4	940	10	2 4	QT-35S QT-35B	1	9.0	$29.95	8 distribution buses. Larger capacity.
PB-102	7.0x4.5x1.4	1240	12	2 3 1	QT-47S QT-47B QT-35B	1	10.0	$39.95	Large capacity, modest price.
PB-103	9.0x6.0x1.4	2250	24	3 4 1	QT-59S QT-59B QT-47B	4	1.3	$59.95	Greater capacity.
PB-104	9.8x8.0x1.4	3060	32	4 7	QT-59S QT-59B	4	1.8	$79.95	Largest capacity.
PB-203**	9.8x6.6x3.3	2250	24	3 4 1	QT-59S QT-59B QT-47B	4	5.0 lbs.	$80.00	Built-in 1% regulated, short proof 5V, 1 amp low-ripple power supply.
PB-203A**	9.8x6.6x3.3	2250	24	3 4 1	QT-59S QT-59B QT-47B	4	5.5 lbs.	$129.95	Same as PB-203. Plus separate ½ amp +15V and −15V internally adjustable (10-16V) regulated power supply

**117VAC 50/60Hz model, and 220VAC 50/60Hz model available at 10% higher cost.

LOGIC MONITORS

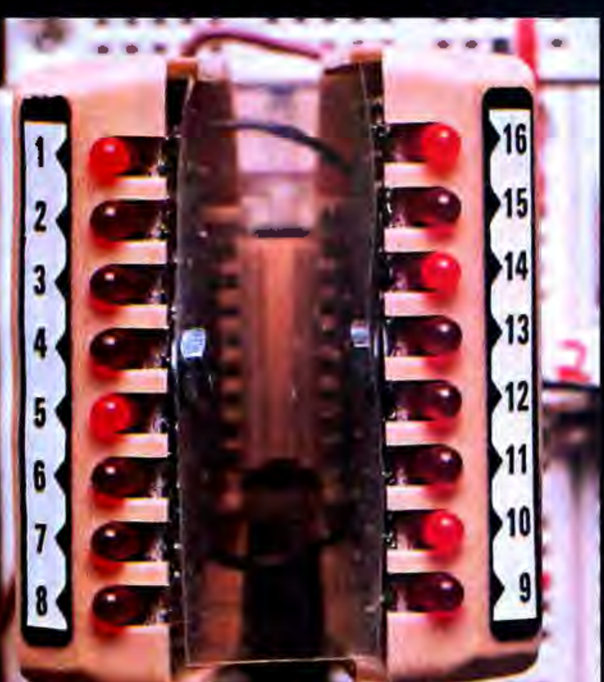
With the speed of light, you can check all digital ICs and get accurate, foolproof, clearly marked readouts.

LOGIC MONITOR 1

The logical answer to inexpensive, effective testing. Self-powered. Self-contained. Pocket-size. Never needs adjustment or calibration. Tests DTL, TTL, CMOS and HTL. Your digital designs spring to life. You can even watch signals working effortlessly through counters, shift registers, timers, adders, flip-flops, decoders, entire systems. Forget probe grounds, pin counting or sync polarity. Just clip LOGIC MONITOR 1 to any DIP IC, up to 16 pins. Precision plastic guides and unique flexible web* guarantee positive connections between non-corrosive nickel/silver contacts and IC leads. Versatile. Fast. Accurate. Indispensable. That's LOGIC MONITOR 1. And, the price is right. Only **$74.95**

SPECIFICATIONS

Input Threshold: 2.0 ± .2V. **Input Impedance:** 100,000 ohms ± 5% all inputs. **Input Voltage Range:** 4V min. to 15V max. across any two or more inputs. **Maximum Current Drain:** 200 ma @ 10V. **Temperature Range:** 0°C to 50°C. **Weight:** 3 oz. (85 grams). **Maximum Dimensions:** (LxWxD) 4 x 2 x 1.5".



Logic levels appear instantly on 16 large (.125" dia.) clearly marked, high intensity LEDs. Logic "1" (high voltage) turns LED on. Logic "0" (low voltage or open circuit) LED off. Power seeking gate network automatically locates supply leads; feeds them to LM-1.

U.S. Patent No. 3,914,007

LOGIC MONITOR 2

Second generation IC tester, with fully isolated power supply to eliminate test circuit loading. 2-units-in 1: Connector/Display that clips over dual in-line packages up to 16 pins. Plus, a modular precision reference Power Supply with its own logic family selector switch. Simply switch to a proper logic family. Then connect black clip lead to NEG or GND. When clip module is slipped over IC, LED instantly, automatically displays logic states of the IC. Can't load down test circuit. Comparators provide constant LED current drive for uniform, bright display. Displays gate rising and falling inputs, while passing pulses from circuit to circuit. See flip-flops change state. Encoders/decoders accepting, recording information. Lots more. All 16 display channels work simultaneously. Order your LM-2 today. Get a lot of logic for a fraction of the price of an oscilloscope. **$129.95** (220V 50/60Hz operation available at 10% additional cost)

LOGIC THRESHOLDS

CMOS: 70% of test unit Vcc ± 100mV
HTL: 7.5V ± 100mV **TTL:** 2.4V ± 100mV
DTL: 1.6V ± 100mV **RTL:** 1.2V ± 100mV
Maximum Visible Input Freq: 30kHz @ 50% duty cycle
Size: (LxWxH) 5.6x6.0x3.0
Weight: 20 oz.
Input Power: 117VAC 50/60 Hz 10W

Heavy thinkers need heavy test equipment they can afford.

LOGIC PROBES & DIGITAL PULSER

LOGIC PROBES

Simpler breadboard testing. That's why CSC Logic Probes were created. These hand-held design/test tools give instant overview of circuit conditions. Just clip power leads to circuit's power supply, set logic family switch to TTL/DTL or CMOS/HTL. Touch probe tip to the test node. Trace logic levels and pulses through digital circuits. Even stretch and latch for easy pulse detection. Best of all, you get instant recognition of high, low or invalid levels, open circuits, and nodes.

Simple dual level detector LEDs tell it quickly, correctly. HI (Logic "1"). LO (Logic "0"). Blinking pulse detector too, e.g. HI and LO LEDs blink on or off, "tracking" "1" and "0" states at square wave frequencies up to 1.5MHz. Pulse LED blinks on for 1/3 second during pulse transition.

There are three models to choose from, depending on your budget, your project, and the speed of your logic circuits.

ORDER YOUR LOGIC PROBES TODAY! SEE YOUR LOCAL DISTRIBUTOR OR USE THE HANDY ORDER FORM ON THE LAST PAGE!

DIGITAL PULSER

After connecting clip leads to POS and NEG power, simply touch DP-1 to a circuit node, and automatic polarity sensor detects the circuit's high or low condition, depress the pushbutton and trigger an opposite polarity pulse into your circuit. Fast, stimulus troubleshooting includes injecting signals at key points in TTL, DTL, CMOS or other popular circuits. Test with a single pulse or 100 pulses per second via built-in dual control pushbutton for selection of single shot or continuous modes. LED indicator monitors operating modes by flashing once for a single pulse or continuously for a pulse train.

ORDER YOUR LOGIC PROBES AND DIGITAL PULSER TODAY! SEE YOUR LOCAL DISTRIBUTOR OR USE THE HANDY ORDER FORM ON BACK PAGE!

LP-1 Hand-held, instant reading of logic levels for TTL, DTL, HTL, or CMOS. **$44.95**

LP-2 The economy version of LP-1. Safer than voltmeter. More accurate than scope **$24.95**

LP-3 High speed logic probe captures pulses as short as 10ns. **$69.95**

DP-1 Completely automatic, pencil-size lab/field pulse generator. Pulse any family of digital circuits. **$74.95**

ACCESSORIES

LDA-1 1.5" Long Tip - Standard. **$1.00.**
LDA-2 2.5" Long Tip - Optional. **$1.00.**

LDA-3 3" Long E-Z Hook and Adapter for use in place of tip - Optional. **$4.25.**
LDA-4 3" Long Ground Clip with E-Z Hook - Optional. **$2.75.**
LDA-5 3" Long Ground Alligator Clip, with LP-3 only - Standard. Optional. **$1.95.**

LDA-6 Test Prod Tip Adapter (Converts tip to E-Z Hook) - Optional. **$2.50.**
LDA-7 Standard Banana Plug (Converts tip for insertion into Banana Plug) - Optional. **$1.60.**

(Not Shown)
LDA-8 36" Power/Ground Leads with Alligator Clips - Standard. **$2.00.**
LDA-9 36" Power/Ground Leads with E-Z Hooks - Optional. **$3.95.**

	LP-1	LP-2	LP-3	DP-1
Input Impedance	100,000 Ω	300,000 Ω	500,000 Ω	Output Tri State
Minimum Detectable Pulse	50ns	300ns	10ns	Autopolarity Pulse Sensing
Max. Input Signal (Freq.)	10 MHz	1.5 MHz	50MHz	Sink and Source 100 ma
Pulse Detector (LED)	High Speed Train or Single Event	High Speed Train or Single Event	High Speed Train or Single Event	Pulse Train: 100pps
Pulse Memory	Pulse or Level Transition Detected and Stored	None	Pulse or Level Transition Detected and Stored	LED Indicator flashes in Single Pulse. *Stays lit* on Pulse Train

Count. Calculate. Create. And accessorize accurately.

MAX-100 FREQUENCY COUNTER

MAX-100. Portable, high precision, lab-quality frequency counter. **MAXimum performance.** Continuous readings from 20Hz to guaranteed 100MHz. Full 8-digit precise readout from crystal controlled timebase with 3ppm accuracy. **MAXimum sensitivity and protection.** Built-in high sensitivity preamp gives readings as tight as 30mV . . . with diode protected input to 200V peaks. **MAXimum visibility.** Bold, bright 8-digit 0.6" display. built-in Flip-up stand. **MAXimum operating ease.** Plug-in. Turn-on. 1Hz readings eliminate range switching and MHz/KHz checks. **MAXimum versatility.** Standard clip-lead cable (supplied), Mini-Whip antenna*, or low-loss in-line tap* with UHF connectors available. Checks AM, FM, CB, Ham R/C computer clocks, digital circuits. Monitors audio, RF generators. **MAXimum self-monitoring.** Input signals over 100MHz (overflow) automatically flash most significant digit, preventing accidental errors. **MAXimum battery life.** Up to 8 hours of normal intermittent use, cued by flashing display weak-power indicator. **MAXimum flexibility.** Compact (1.75" x 7.75" x 5.63"). Portable from 4 power sources. Internal alkaline or rechargeable NiCad AA batteries. 110 or 220VAC with charger/eliminators*. 12V auto cigarette lighter charger/eliminator. External 7.2-10V power supply (batteries not included).

MAXimum value. You get all this, and more in the industry's best frequency counter value.

MAX-100. **Only $134.95**

*Optional

ORDER YOUR MAX-100 TODAY!
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OR USE THE HANDY ORDER FORM ON THE BACK PAGE!

ACCESSORIES

Model 100-CA1/ Model 100-CA2 Charger / Eliminators for 6 Rechargeable Ni-Cad AA cells **$9.95 each**

Model 100-IPC Input Cable with Clip Leads. (Included. Additional units available.) **$5.95**

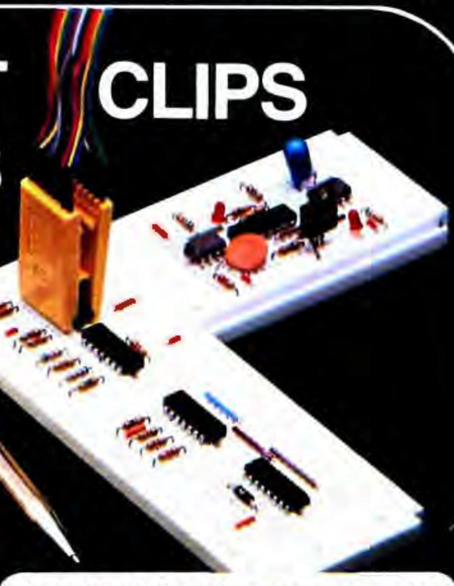
Model 100-MWA Mini-Whip Antenna. For direct-coupling to RF equipment. Displays frequencies of nearby portable transmitters. **$3.95**

Model 100-CLA Mobile Charger/Eliminator $3.95

(Not Shown)
Model 100-LLC Low Loss Tap Off connects to equipment or RF line under test. 3W rating. **$14.95**

Model 100-CC Carrying Case. Soft simulated leather. **$9.95**

PROTO-CLIP™ I.C. TEST CLIPS & DESIGN MATE™ CASES



Clip-on. Fool-proof. Short-proof. Power-on. DIP-in. Circuit testing that's right-on . . . for less!

Take *your* choice from four (4) low cost micro-trouble-*shooters*. Narrow, deep throat brings IC leads up from crowded pc boards for fast signal tracing, testing, signal injection, even wiring unused circuits into existing boards. Your hands are free to scratch an itch or dig into electronic problems. High impact plastic construction means no more springs or pivots to pop out at critical moments. Molded flexible web* insures positive operation every time, for thousands of uses. Non-corroding nickel/ silver contacts give simultaneous, low-resistance connections to all IC leads. Pick a size. Pick a need. Pick a price. Place an order. Now!

Unique gripping teeth for slip-proof, hands-off probe connections.

Clips

PC-14 (14-pin) **$4.50** PC-16 (16-pin) **$4.75** PC-24 (24-pin) **$8.50** PC-40 (40-pin) **$13.75**

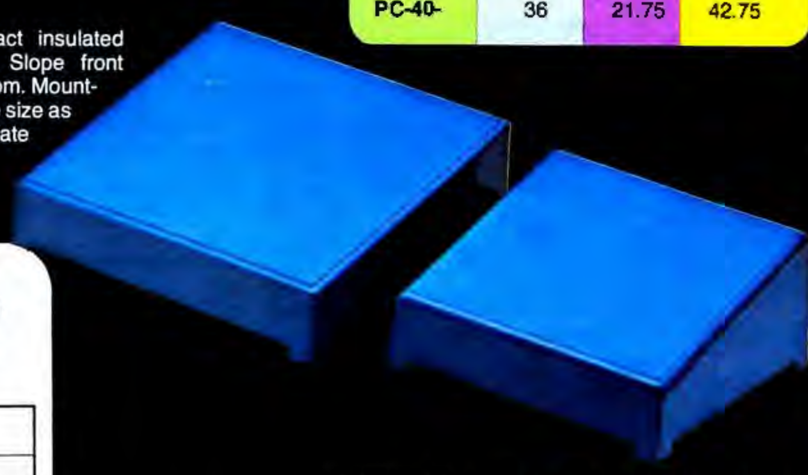
*U.S. Patent Design No. 3,914,007

Proto-Clip I.C. Test Clips with pre-wired cables

Model No.	Cable length inches	Price Single Clip	Price Dual Clip
PC-14-	18	$7.75	$14.75
PC-14-	24	8.00	15.00
PC-14-	36	8.50	15.50
PC-16-	18	8.50	16.00
PC-16-	24	8.75	16.25
PC-16-	36	9.25	16.75
PC-24-	18	$12.25	$25.25
PC-24-	24	12.50	25.50
PC-24-	36	13.00	26.00
PC-40-	18	21.00	42.00
PC-40-	24	21.25	42.25
PC-40-	36	21.75	42.75

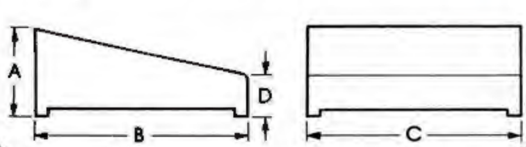
Cases

DMC-1. Hi-impact insulated plastic. 1-piece. Slope front panel. Metal bottom. Mounting screws. Same size as popular Design Mate Units **$6.95**

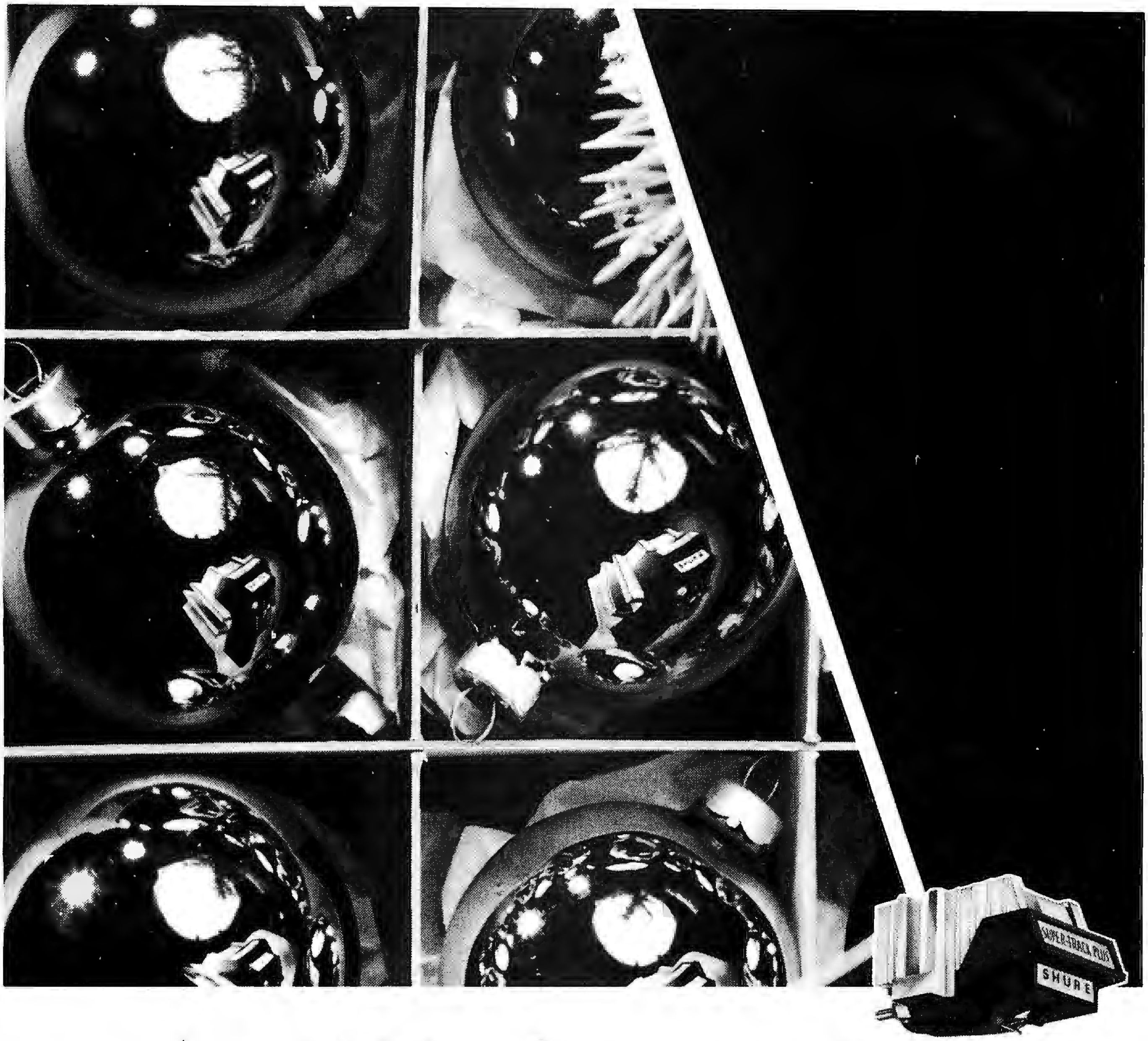


DIMENSIONS

MODEL	A	B	C	D	Weight
DMC-1	3.25"	6.75"	7.5"	1.5"	12 oz.
DMC-2	3.0"	5.63"	6.0"	1.5"	10 oz.



DMC-2. Same features as DMC-1, but slightly more compact **$5.95**



A cartridge in a pear tree.

A gift of the Shure V-15 Type III stereo phono cartridge will earn you the eternal endearment of the discriminating audiophile who receives it. What makes the V-15 such a predictable Yuletime success, of course, is its ability to extract the real sound of pipers piping, drummers drumming, rings ringing, et cetera, et cetera. In test reports that express more superlatives than a Christmas dinner, the performance of the V-15 Type III has been described as "... a virtually flat frequency response... Its sound is as neutral and uncolored as can be desired." All of which means that if you're the giver, you can make a hi-fi enthusiast deliriously happy. (If you'd like to receive it yourself, keep your fingers crossed!)

Shure Brothers Inc.
222 Hartrey Ave.,
Evanston, IL 60204
In Canada:
A. C. Simmonds & Sons Limited

TECHNICORNER
MODEL V-15 TYPE III
Tracking Force Range: ¾ to 1¼ grams
Frequency Response: 10 to 25,000 Hz
Output: 3.5 mV per channel at 1 KHz, 5 cm/sec peak recorded velocity
Typical Tracking (in cm/sec peak recorded velocity at 1 gram in a Shure-SME Tone Arm):

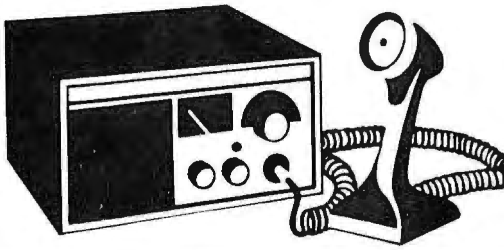
400 Hz	26 cm/sec
1,000 Hz	38 cm/sec
5,000 Hz	35 cm/sec
10,000 Hz	26 cm/sec

Channel Separation (Minimum): 25 dB at 1 KHz; 15 dB at 10 KHz
Stylus: Model VN35E Biradial Elliptical, 5 x 18 microns (.0002 x .0007 inches)
Also available: Model V-15 III G with the VN3-G Spherical stylus, 15 microns (.0006 inches)
Model VN78E Biradial Elliptical stylus, 13 x 63 microns (.0005 x .0025 inches) for mono 78 rpm.

® SHURE

Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

CIRCLE NO. 57 ON FREE INFORMATION CARD



CB Scene

By Gary Garcia, KQI4178

RULES ENFORCEMENT GAME PLAN

EFFECTIVE enforcement of the Citizens Band Radio Service rules and regulations is a vexing duty of the Federal Communications Commission. Unruliness sometimes abounds on the CB frequencies, most noticeably in urban areas where the CB population is most concentrated. Except for an infrequent "strike" (the process of identifying, inspecting, and citing illegal operators by a team of FCC engineers), evidence of CB rules enforcement is practically nonexistent.

The FCC has not yielded to the rulebreakers among us, however. In fact, a recent study by the FCC of the effectiveness of various enforcement techniques suggests that the Commission is determined to increase the level of compliance with the rules of the Citizens Band Radio Service as a means of improving CB communications quality.

Violations. Transgressions impair CB communications quality—the ability of an authorized CB user to establish communications within an acceptable waiting period and complete the communication without undue difficulty. Most harmful are unnecessary, illegal transmissions, says the FCC. Indeed, transmissions of music, sound effects, unmodulated carriers, and obscenities are a major component of the "electromagnetic obstacle course" present in some areas on the 11-meter band.

Interestingly, the FCC study included CB operator behavior on different days of the week. It was learned that the magnitude of violations differed very little from day to day, though statistical results indicated that greatest rules compliance was observed on Fridays and least on Saturdays.

Infractions deemed to be of most importance and equally so by the FCC are:

1. Out-of-band communications.
2. Excessive r-f output power.
3. Communication beyond 150 miles.
4. Failure to identify by callsign.
5. Violation of local or federal law.
6. Profane or indecent language.

Enforcement Techniques. What measures are necessary to promote compliance with the CB rules and regulations? The *conventional* enforcement technique is the so-called "strike," conducted by two pairs of FCC engineers in a particular area.

A somewhat similar method of enforcement is the *criminal sanction* technique. Again, teams of two FCC engineers investigate and *identify* serious violators. Thereafter, however, this evidence of illegal operation is referred to U.S. Attorneys for initiation of criminal prosecution. The conventional and criminal sanction techniques are the most cost-effective methods investigated during the course of this recent FCC study.

An *educational* technique is employed by the FCC, too. This method consists of a week-long visit to a community by a single FCC engineer. During this period, the engineer conducts an intensive CB Education Program. Slide/sound programs are presented at meetings of CB groups, followed by discussion and question-and-answer sessions. Members of the media in the community visited are contacted to provide publicity for the programs to be conducted during the week; and TV and radio appearances are made by the engineer. "On-the-air" question-and-answer sessions are held on a previously selected CB channel, and even CB dealers are contacted and visited by the engineer. The educational technique is often augmented by the conventional technique to produce the *educational and criminal sanction technique*. This method proved to be more effective than the educational technique alone, but did not produce the results observed after application of the conventional or criminal sanction techniques due to the shortened investigative period. Moreover, although this program has been well received by the CB community, it has not resulted in a significant improvement in rules compliance. Further, rules breakers were not unaware of existing rules and regulations. Violation notices, by the way, carry fines of $50 to $100 for each violation

as follows:

- Excessive power: $100
- Skip communications: $75
- Overheight antenna: $75
- Failure to use callsign: $50

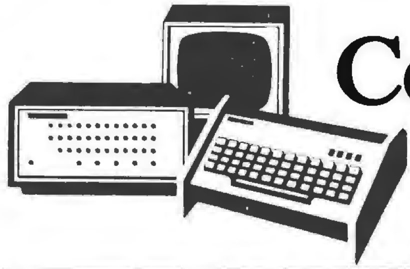
Additional Studies. The study of cost-effectiveness of the various compliance techniques previously mentioned is only one phase of a three-phase program. Additional studies are planned on the relationship between rule compliance and communications quality, and between communications quality and general public benefit derived from use of the Citizens Band Radio Service.

If the level of rules compliance by CB users does not reach an acceptable level, we can be sure that the FCC will eventually take action. Judging from previous actions, we can't guess what new decisions will likely be made. The FCC is simply too erratic. On one hand, rulings were made with the amateur radio fraternity in mind rather than the general public. So, it's no surprise that there are some serious violations of CB rules by people whose numbers loom large simply because they're a small percentage of more than 20-million CB'ers. Alternatively, the FCC has backed off on some earlier rules—simplifying callsign identification, eliminating Form 452 which had to be displayed in a mobile, etc. Will the FCC be pressured by its inherent policing weakness to further dilute the rules? A User Rule Compliance Task Group in PURAC determined that the following technical factors could foster rule compliance, aside from educational and self-policing efforts:

1. ATIS (automatic transmitter identifier systems.)
2. Time-out timers to limit conversations to five minutes.
3. Linear amplifier sensors to inhibit delivery of power to linear amplifiers.
4. Antenna fuses so that CB antennas can handle only maximum power ratings.
5. Channel 9 deterrent that would use a two-frequency simplex system.

We can see many holes in the foregoing proposals, aside from added cost to the end user. For example, an emergency communication might require more than five minutes talk time. Further, intra-stations (base/mobiles that hold the same station license) are not limited to five minutes talk time. Another example: The use of ATIS. The time to make mandatory installation of this automatic identifier system was *before* there were so many millions of CB rigs in use. This old-hat proposal was turned down by the FCC earlier when it was possible for it to be used effectively.

We agree that it's unfortunate that FCC rules are being broken, and that these uncourteous actions are a detriment to legal CB communicators. But let's not condemn all CB'ers. Nor should one assume that CB users are the type of people who don't comply with the law. Here are some figures to ponder in this respect: The percentage of time that FCC field operations expend on violation enforcement for CB is 21.7%, resulting in 10,173 violation notices in the last three fiscal years. In contrast, here are the percentages of time spent in some other communication areas, with the number of violation notices during a three-year period in parentheses: Marine, 7.5% (19,054); Broadcast, 7.0% (5,823); Amateur, 2.9% (4,154). Furthermore, about 3/4 of the time spent on CB was for TVI purposes. Given the much greater number of CB'ers as compared to other services, these statistics demonstrate that the Citizens Band Radio Service is not alone in the need for more effective rules enforcement. ◇



Computer Bits

By Leslie Solomon

POTPOURRI FROM HERE AND THERE

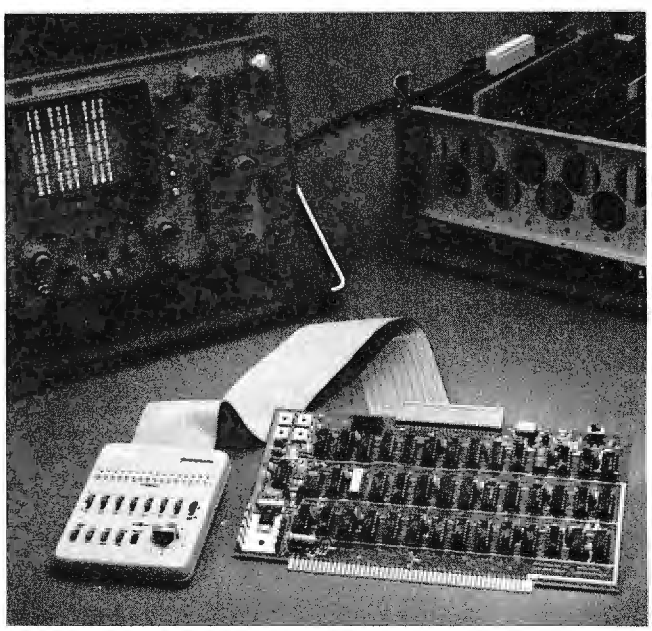
HERE ARE a number of interesting hardware and software items to titillate the computer hobbyist. Some were brought to our attention through the mail; others were spotted at the Personal Computing show in Atlantic City.

16K for SWTP Computers. Gimix Inc. (1337 W. 37th Pl., Chicago, IL 60609; Tel: 312-376-0440) has introduced a 16k static RAM board for the SS-50 (SWTPC) bus. Using TMS4044 4k-by-1 bit fully static RAM's, each 4k block is switch addressable at any 4k boundary, while memory write protect and memory disable are controllable in 4k switch-selectable blocks. Special features include each 4k block software programmable to any address at 4k boundaries, and software control of write protect and memory disable. This allows multi-tasking with just one 16k board and a little software overhead; it also permits memory beyond 65k.

New Logic Analyzer. In February 1977, POPULAR ELECTRONICS introduced the first logic analyzer kit for the computer hobbyist. This electronic tool has since become a very popular instrument for debugging hardware and software. However, before the instrument can be used, several independent test leads must be connected to the microprocessor system—not an unusual requirement, but a chore nonetheless. Now, the designers of the original logic analyzer have developed a refined version that eliminates these steps, at least for Altair S-100 bus mainframes. It's called the Model 150 Bus Grabber ($359 in kit form, $449 assembled, and available from Paratronics, Inc., 800 Charcot Ave., San Jose, CA 95131; Tel: 408-262-2252).

Paratronics has crammed a complete logic analyzer on a single multilayered pc board that can be directly plugged into this popular bus. Working in conjunction with a hand-held "pod" that contains all the switching, the Bus Grabber monitors 64 signals—56 through the board edge connector, and 8 (user defined) through an 8-lead probe assem-

Paratronics' Bus Grabber is analyzer on a pc board.



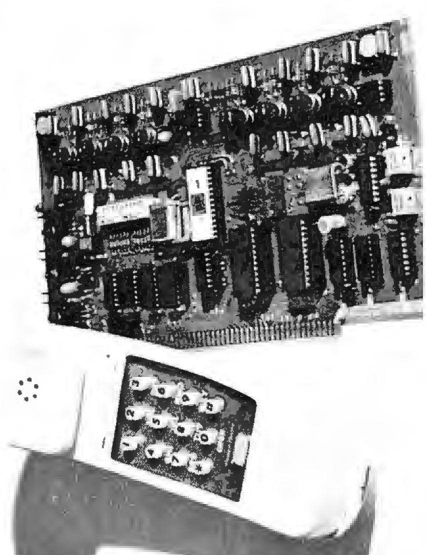
bly. Three connectors couple the board to the scope vertical, horizontal, and intensity inputs.

The display is data domain (1's and 0's truth table); size is 1 byte by 16 words deep; and display can be either octal or hex. Display modes are single or repetitive. Data collection is in either positive or negative time and memory size is 16 bits by 16 words. The trigger word can be 24 bits wide (16 bus address lines and 8 input data lines). The same flexible trigger is also featured, as is the scope trigger for "glitch" analysis. Data is collected at greater than 8 megabytes per second.

The hand-held pod makes operation very simple. Triggering, display formatting, and operational modes of the Model 150 are controlled from this pod, which is ribbon-cable connected to the main board. An 8-position switch on the pod enables looking at the external inputs, MPU control signals, MPU interrupts, MPU status, MPU data bus in, MPU data bus out, and the upper and lower address bytes. With this selection, and a simple program, it is easy to take a look at just about every important signal.

The Bus Grabber takes 700 mA from the -8-volt bus, and 50 mA from the +16-volt bus.

Telephone Interface. If you would like to interface your Altair S-100 bus computer to the Touch-Tone ® telephone system, MK Enterprises (8911



MK Enterprises' MK-II DTMF transceiver board with phone.

Norwick Rd., Richmond, VA 23229; Tel: 804-285-2292) has just the device for the job. Its MK-II dual-tone, multi-frequency (DTMF) transceiver board converts the DTMF (Bell Standard) into binary, and binary into DTMF, making this a fully operational transceiver. The board comes fully assembled and tested with application information and a manual for $425.

On incoming calls, vectored interrupts allow for ring detection as well as detecting the presence of DTMF signals. This permits phoning into the computer and executing programs by punching the correct tone pad sequence on the remote phone. On outgoing calls, the dialed digits are loaded into a FIFO (first in first out) buffer at processor speed, then unloading the data into a DTMF tone generator at a rate compatible with the Bell System's equipment. A 4-bit output port allows supervision of trunk interface equipment (DAA devices). Single tones can be generated instead of dual tones (under software control).

Applications of the MK-II include monitoring and tabulation of outgoing phone calls, home security "dialers," and PABX systems. Remote operation of ac applicances is also possible by 60-Hz modulation with DTMF signalling.

KIM Doings. If you are a KIM user, or are about to get a KIM, you should also get a copy of the "First Book of KIM" ($9 from ORB, P.O. Box 311, Argonne, IL 60439). The book is divided into six useful sections, and starts with a viewpoint of the absolute beginner, discussing KIM programming from ground zero. It covers RAM, ROM, hex numbering, program loading and running, and how the KIM works on a step-by-step basis with simple exercises as a learning aid.

The second portion covers 27 games (with full listings) that include some of the better-known BASIC games such as blackjack, lunar lander, and table tennis. A "music box" program that uses the audio output connector of KIM is also included in this portion.

The third section covers 13 utility programs that include Hypertape (allows loading a full lk in 21 seconds), a directory program, a memory test, a move-data-anywhere program, a KIM phase-locked-loop test, a bubble-sort program, and three useful tape programs: Superdupe, allowing duplication of a tape quickly; Tape Verify, for verification of a just-recorded tape; and Vutape, which lets you see the contents of a KIM format tape as it goes by.

The Expansion section discusses the number of ways that the KIM can be expanded from both hardware and software viewpoints. The Interface section illustrates some low-cost hardware additions.

The last section, called Pot-Pourri, covers guidelines for writing KIM programs, some useful notes on the KIM display, a KIM alphabet for displaying alphanumerics, a random-number program, a listing of the many KIM articles and some 6502 software sources. Altogether, a good book for KIM persons.

65K Board. Every computer hobbyist probably needs more memory. There is also no doubt that most hobbyists have been buying peripherals for Altair S100 bus systems. This, of course, brings up the problem of slot space.

The approach used by Extensys Corp. (592 Weddell Dr., S-3, Sunnyvale, CA 94086; Tel: 408-734-1525) to solve both the extra memory and slot space problem is to create a single board that can hold up to 65,536 bytes and has hardware provisions for bank switching to 1 million bytes or more.

The basic RM64-16 Dynamic Memory Board sells for $595 and comes with 16k of RAM, but it is socketed for all 65k. Also available are the RM-32 for $895 (32k), the RM-48 for $1195 (48k), and

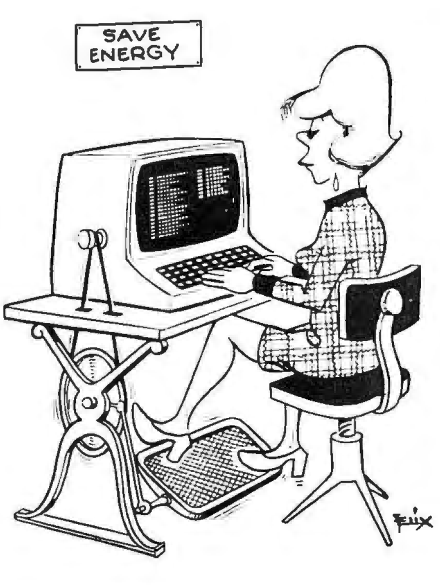
the RM-64 for $1495 (64). If you just want to increase the basic 16k board, then a 16k upgrade kit is available for $375. Other boards include the MM16 Memory Manager at $295.

Power requirements are +12 volts at 300 mA, +5 volts at 750 mA, and −5 volts at 1 mA. The memory board has a cycle time of 500 ns and a 400-ns access time.

If you are wondering how you can have 64k of RAM and a few k of ROM with a single 8-bit processor, the new board uses "bank switching" and a special provision that allows for memory overlap. A "Read" may occur from both RAM and ROM, but the bus drivers are inhibited on the RAM board to prevent bus conflict. This allows ROM "Reads" to have precedence over RAM "Reads." From a hardware perspective, it means adding one small lead to the present computer bus. There is also "Write" protection in 16k blocks and board select logic that allows for more than one 64k byte board per system.

TI Programmer. Probably the most widespread digital device used today is the calculator. Available in a variety of types, from the simple "four banger" to complex programmable models, they all have one thing in common—they operate with decimal input and deliver decimal readout.

There is a new guy on the block, designed specifically for computer hardware and software types: the Texas Instruments "TI Programmer" ($49). The main feature of this unique calculator is that it can perform arithmetic functions in either decimal, octal, or hex with the capability of converting from one base to another at the operation of a single key.



Other features include: signed floating point arithmetic for conventional computations (decimal), a 1's complement key for octal and hex, 15 sets of parentheses at each of the four processing levels, independent memory with summation to memory capability, and ability to perform logic operations such as OR, AND, XOR in octal and hex. A constant mode allows operations with a constant number for all arithmetic and logical operations. A battery saver and automatic turn-off are provided for longer battery life.

Each of the 15 keys used in entering numerical data (to FFFF in hex) is also identified by its binary code printed under each key.

If you do any programming where you have to convert from octal to hex, or vice versa, or you must know the decimal equivalent of an octal/hex number, you really have to take a look at this new low-cost pocket calculator. It is a real time saver. One of our software buddies insists that he can work out quite a bit of his programs with this calculator, enabling him to work away from his computer.

SWTP Firmware. Since the introduction of the SWTPC (Southwest Technical Products Co.) 6800 Computer System, Motorola's MIKBUG has been supplied as the mini-operating system. Although this monitor has proven to be an excellent one, the staff at SWTPC has accumulated a list of additions and modifications to MIKBUG, thereby creating their version called SWTBUG (or Swatbug). Sixteen major subroutines have been positioned with the same entry points as MIKBUG so that most programs which are MIKBUG compatible will also run with the Swatbug, without modification.

The new monitor supports an ACIA MP-S Serial Interface at I/O port-1, as well as a PIA MP-C Control Interface at I/O port 0 or 1. This allows users who have a MP-C Control Interface to use Swatbug without an additional MP-S Serial Interface option. It also permits users who have an MP-S Serial Interface to operate their control terminal from 110 to 9600 baud on the MP-S; an optional MP-C handles the "Kansas City" A -30 Cassette Interface at 300 baud.

The new monitor also generates MP-C Control Interface signals for reader-on, reader-off, punch-on and punch-off. This eliminates terminal control character decoding as used with MIKBUG. The MIKBUG INEEE and OUTEEE subroutines reside at the same addresses in Swatbug.

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The incredible Bally Fireball® pinball game you've been hearing about now in low-cost easy-to-build kit form. One to four players can play this exciting game that's so challenging its impossible to grow tired of. Solid-state electronics and computer technology replace much of the failure-prone electromechanical devices found in other games. The GD-1110 is not a toy but a sophisticated pinball game that will give you years of fun and action.
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You'll appreciate the CS-1048 every time you take a long trip in your car. Just preset your cruise speed and the CS-1048 does the rest electronically. Maintains your car's speed, can help improve mileage too.
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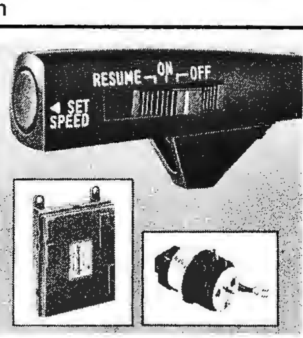

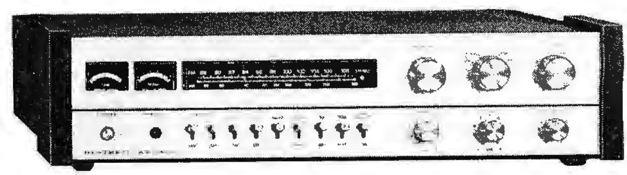

New AR-1429 Stereo Hi-Fi Receiver

This year give symphonies, cool jazz, and the driving beat of rock with this stereo performer from Heath. 35 watts, minimum RMS, per channel into 8 ohms with less than 0.1% total harmonic distortion from 20-20,000 Hz. The AR-1429 is perfect for the budget conscious stereo buff who requires a high quality system. It has all the features of a high-priced receiver and the performance too. Phono hum and noise are −65 dB. FM sensitivity is 1.8 μV. Provision for optional Dolby® FM module. Only $319.95

New GD-1186 Digital Electronic Scale

Unique and functional truly describe the new Digi-Scale electronic "weighing machine". Big, bright LED's show your weight with more precision than normal scales and there are no springs or weights to compromise performance. The digital readout may be mounted on the wall or just about anywhere.
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New TO-1860 Heath/Thomas Organ

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COMPUTER BITS

(continued from page 121)

Swatbug also makes it possible for the user to set single-level breakpoints within user programming for debugging purposes. Furthermore, the monitor generates a "home" and "erase" command for the SWTP CT-1024. It also erases each CT-1024 line before writing a new one and vectors all software interrupt instruction to a location pointed to by a user-defined address located in scratchpad RAM. Moreover, Swatbug boots in the new SWRPC MF-68 Minifloppy Disk by typing in a single character (D).

Other Swatbug commands include cassette or paper tape dumps and appends the now-famous "S9" to the end of the tape, and outputs all of the record/punch (on/off control commands as well).

All SWTPC 6800 Computer Systems with MIKBUG can use the SWTBUG by replacing the socketed MIKBUG with the new chip and making one minor change on the board. The SWTBUG sells for $19.95 pp.

Video Monitors. If you are thinking about modifying a TV receiver for use as a monitor for your computing system, you should be aware that VAMP, Inc. (P.O. Box 29315, Hollywood, CA 90029) is making available its ADVM-1 at $23.95. This is a universal conversion kit for either transformer-powered receivers or "hot" chassis types. According to VAMP, the kit can be used with any TV receiver. When installed, it provides the necessary isolation to ensure safety and protect the video source. It is said to produce up to 80 characters per line. The kit bypasses the tuner and i-f strip, and a bypass switch is provided for normal TV viewing.

VAMP also offers its RFVM-1 at $8.95 for installation in the video source. It can be tuned from channel 2 to channel 6.

COSMAC Elf News. A Canadian electronics supplier, Tektron Equipment Corp. (Caistor Centre, Ontario, Canada LOR 1EO) has started a newsletter directed to some 300 1802-MPU-based computer owners in the area. They're trying to form a microprocessor club which will be heavily oriented toward the 1802 MPU's. Domestically, an Elf Users Group is being formed for all 1802 fans by Netronics Inc. (333 Litchfield Rd., New Milford, CT 06776). An exchange of hardware and software ideas is planned for the groups. ◇

Electronics Library

ADVANCED AND EXTRA CLASS AMATEUR LICENSE Q&A MANUAL

by Marvin Tepper

Based on the FCC syllabus-type study guides, this book covers the material appearing on the Advanced and Extra Class theory exams. Within the chapters dealing with each exam, the questions are arranged in such categories as Rules and Regulations, Radio Phenomena, Operating Procedures, Emission Characteristics, Electrical Principles, Practical Circuits, Circuit Components, Antennas and Transmission Lines, and Radio Communication Practices. Other chapters deal with general information and Morse code requirements. Three appendices include practice examinations and answers, excerpts from the Communications Act of 1934 and Part 97 of the FCC Rules and Regulations, and Docket No. 20282 (Proposed Restructuring of the Amateur Radio Service).

Published by the Hayden Book Co., Inc., 50 Essex Street, Rochelle Park, NJ 07662. 160 pages. $5.95 soft cover.

99 WAYS TO IMPROVE YOUR CB RADIO (SECOND EDITION)

by Len Buckwalter

Helpful hints for the CB'er are presented in this book. Section One covers antennas—installation, maintenance, reconditioning, adjustment, and antenna gain. Section Two covers interference suppression, and the following two sections discuss general maintenance and station accessories. Operational techniques and aids are presented in Section Five. The final section contains additional information on activities and programs of interest to the CB'er.

Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46206. 128 pages. $3.95, soft cover.

GETTING INVOLVED WITH YOUR *OWN* COMPUTER

by Leslie Solomon and Stanley Veit

Here is a solid, well-rounded introduction to home computer fundamentals for the neophyte. There are clear, concise explanations of computer anatomy, kit-building basics, and computer peripherals and I/O devices. Most of the major home computer systems are described in sufficient depth to help the beginner narrow down his search for a system. There is a chapter covering sources of more

(Continued on page 153)

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Knight Kit Star Roamer. Schematic and alignment data. Zenen Martin, 4022 Bell Ave., Bronx, NY 10466.

CRT Tube. Need source of one CP1. Curtis A. Cook, 6507 Washington, Des Moines, IA 50322.

Scott Model LK-48-B stereo amplifier and **Bell & Howell** Model "C" Design-138 movie projector. Schematics and/or instruction manuals. D. Buechner, 302 Roanoke, Warrenton, MO 63383.

Eico Model 425 oscilloscope. Need owner's manual and schematic. Dave Siever, 10915-141-St., Edmonton, Alberta, Canada T5M 1T3.

John Meck Industries Model RC-5B5 Trail Blazer AM receiver. Schematic and power requirements. Ron McCay, 1200 N. Park Ln. #4, Altus, OK 73521.

Heath Model HW32 20-band transceiver. Manual and schematic. Dom Sagolla, 141 N. Eagle Rd., Havertown, PA 19083.

National Model MC-33. Schematic and service manual. William H. Bragg, 1424 College, Des Moines, IA, 50314.

C.M. Laboratories Model 911 power amplifier. Schematic needed. Kenneth G. Larson, 4070 Rupley Place, Riverside, CA 92505.

Power Mate Corp. Model BP-34D power supply. Schematic needed. D.I. Johnson, Box 171, Sherborn, MA 01770.

Precision Series EV-20 VTVM. Operation manual and/or schematic. A.J. Melito, 3021 Garland St., Erie, PA 16506.

National Model NC-2-40D. Schematic needed. K.P. Mitchell, Route 1, McLeansboro, IL 62859.

Zenith Model L600 trans-oceanic radio. Schematic and maintenance information. John Hay, Route 2, Box 55, Exchange, WV 26619.

Howard Model 518 shortwave radio. Need schematic. Tom Knight, 1309 Hobbs Dr., Alpena, MI 49707

Hallicrafters Model S-38C receiver. Schematics and service manual. W.H. Barkemeter, 1945 C.G. OL-F, Box 153, APO, NY 09053

Toshiba Model SA-20Y stereo receiver. Schematic needed. Edward Wirth, Jr., 3123 West Galena St., Milwaukee, WI 53208

Knight Model KN 2590 citizens band radio. Need any available information and/or operation manual. Leonard Pezderic, RR 2, Box 109, Mason, WI 54856

U.S. Navy Model RAK-7 WWII vlf receiver. Need manual. J.G. Rowland, 64 Ridge Ave., Rark Ridge, NJ 07656

JWD Model 100 PA amplifier. Need schematic. R.D. Cornell, Box 202, Glennville, GA 30427.

Metz Model 1512M AM/FM/SW receiver. Any available information. P. Boychuck, 205 S. Olds Blvd., Fairless Hills, PA

U.S. Army Signal Corps BC-794B, 1304-CHC, 9092-PHILA-44 radio receiver. Need operation manual and schematic, also type and source of crystal used. T. Remington, 19851 E. Comstock Rd., Linden, CA 95236.

U.S. Air Force Model ARC-33 (RT-173 or DY-63) uhf transceiver. Schematics and/or operation manual. David McFalls, 626 Seminole Dr., Kemah, TX 77565.

OS-34 USM 32 oscilloscope. Wiring diagram or manual needed. S. Bostwick, 2015 Virginia Ave., McLean, VA 22101.

Nova-Tech Model RDF-404 Pilot II direction finder. Need

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.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
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3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
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10/35V	.09	.70/10	7.28/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.13	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.17	.80/10	6.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.55/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.11	.85/10	7.28/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.13	1.13/10	10.41/C	.19	1.51/10	12.85/C
45/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.32/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.20/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.15	1.82/10	12.05/C
220/16V	.15	1.19/10	9.98/C	.20	1.55/10	13.20/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.46/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.19	1.64/10	15.13/C
330/16V	.20	1.60/10	14.14/C	.31	2.45/10	20.72/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.35	2.86/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.27	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

Bishop Graphics

The Digi-Key Catalog lists many more quality Bishop Graphics products

$12.50

JMJ DIGITAL DISPLAY BEZEL

NEW

$4.95

PATENTED CHROMAFILTER SCREEN, DIE CAST METAL FRAME MOUNTS IN PANELS UP TO 3/16" THICK. NO EXPOSED HARDWARE. SCRATCH RESISTANT AND EASILY CLEANED. ELIMINATES GLARE.

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400	BEZEL WITH RED FILTER	4.95
420	MOUNTING ADAPTER FOR MA1001 & MA1002	.69
421	MOUNTING ADAPTER FOR MA1010	.69

CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green fluorescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM/PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module with Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	.84" LED 12 Hour AM/PM Clock Module	$13.00
MA1010A SET	Module with Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module with Transformer & Switches	$16.45

MA1002 0.5" High Digits — Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits — Actual size: 1.75"x3.75"

MA1003 $24.95 NEW!

LED DIGITS AND LAMPS

FND357	.375" Single Digit CC Red	$1.35
FND500	.5" Single Digit CC Red	1.35
FND507	.5" Single Digit CA Red	1.35
FND800	.8" Single Digit CC Red	2.50
FND807	.8" Single Digit CA Red	2.50
NSN373	.3" Dual Digits CC Red	2.20
NSN374	.3" Dual Digits CA Red	2.20
NSN583	.5" Dual Digits CC Red	2.60
NSN584	.5" Dual Digits CA Red	2.60
NSN783	.7" Dual Digits CC Red	3.00
NSN784	.7" Dual Digits CA Red	3.00
NSL5053	Dif Red T-1¾ Lamp w/Mtg Hdwe	$1.80/10 $16.00/100
NSL5056	Dif Narrow Angle Red T-1¾ Lamp w/Mtg Hdwe	$1.80/10 $16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

RS125 ... $9.90
RS225 ... $9.90

½ WATT RESISTOR ASSORTMENTS

RS150 ... $9.90
RS250 ... $9.90

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4½" Length

See Our Catalog For More Diamond Tool

MES4 $6.58

$18

Digi-Key Stocks the Entire AP Line

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$5.95
$6.95

STRIPS — WRAPS — UNWRAPS

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M
TIP120	.99	9.20/10	85.00/C	800.00/M

½ WATT ZENER DIODES

.15 1.30/10 11.00/C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5230B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

HARDWARE

2-56 1/4 SCREW	.99/C
2-56 1/2 SCREW	.99/C
4-40 1/4 SCREW	.55/C
4-40 1/2 SCREW	.60/C
6-32 1/4 SCREW	.65/C
6-32 1/2 SCREW	.75/C
8-32 3/8 SCREW	.90/C
8-32 5/8 SCREW	.99/C
2-56 HEX NUT	.55/C
4-40 HEX NUT	.55/C
6-32 HEX NUT	.60/C
8-32 HEX NUT	.60/C
NO 2 LOCKWASHER	.85/C
NO 4 LOCKWASHER	.45/C
NO 6 LOCKWASHER	.45/C
NO 8 LOCKWASHER	.45/C

SILICON DIODES

1N4001	.64/10	5.50/C	$49/M
1N4002	.66/10	5.60/C	$51/M
1N4003	.68/10	5.80/C	$52/M
1N4004	.70/10	5.95/C	$54/M
1N4005	.82/10	7.05/C	$63/M
1N4006	.90/10	7.75/C	$69/M
1N4007	.99/10	8.60/C	$77/M
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FREE CATALOG

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MOS LSI I.C.'s 713 P.	$4.00
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VOLTAGE REG I.C.'s 128 P.	$3.00
LINEAR AP I 432 P.	$4.00
LINEAR AP II 246 P.	$3.00
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FET DATABOOK	$3.00
CMOS 4000 278 P.	$3.00
ANALOG MANUAL 637 P.	$5.95

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8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.75/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

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SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.22	2.00/10	19.00/C

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100	10.00/500
22 ga PVC	2.80/100	11.25/500
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26 ga PVC	2.10/100	8.50/500

50 VOLT DISCS

100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
.001 UF	.40/10	3.50/C
.0022 UF	.40/10	3.50/C
.0047 UF	.40/10	3.50/C
.01 UF	.45/10	3.65/C
.022 UF	.50/10	4.00/C
.047 UF	.70/10	5.60/C
.1 UF	1.35/10	11.50/C

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8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted allow 6 to 8 weeks for delivery.

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Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

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Board fully assembled and tested for $50. extra.

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+8VDC 400MA DC
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MEMORY ACCESS TIME IS 375ns.
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8K LOW POWER RAM - $159.95

Fully assembled and tested. Not a kit.
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CHECK THE ADVANCED FEATURES OF OUR Z-80 CPU BOARD:
Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets priced for all IC's. *Add $10. extra for Z-80A chip which allows 4MHZ operation. Z-80 chip with Manual — $39.95

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One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: —Dixie — Eyes of Texas — On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai

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Features: Litronix dual 1/2" displays. Uses Silicoaix LD131 single chip CMOS A/D converter. Kit includes all necessary parts (except case); AC line cord and power supply included. O-149° F

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Greatly simplified construction. More reliable and easier to build. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle — avoid the 5314! Do not confuse the Non — Alarm kits sold by our competition!
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FEATURES· **$16.95**
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Bowmar 4 Digit LED Readout Array

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WITH COLONS & AM/PM INDICATOR
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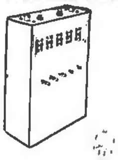

Features: Large LED ." displays, crystal controlled Mostek 50397 counter display driver, set timer at 0.1 second precision from 0.1 second to 59 minute 59.9 second, 5A-115V relay included to control photographic enlarger, sun lamp, appliances, TV, or other equipment, operates on 115V AC, displays can be turned off for total darkness applications, simple push button operation, use in kitchen, school, office or laboratory. All necessary parts included. Special design case $3.75

6 Digit General Purpose or Computer Timer Kit - $29.95

Features Large LED " displays, Mostek 50397 counter display/driver, counts up to 59 minutes, 59.99 seconds with crystal controlled 1 100 second accuracy, operates on 115V AC or 12V DC supply. Use it to time telephone calls, athletic events, practice time, school and laboratory demonstrations, experiements, chess games, etc Time computer functions in real time such as run times on programs, sub routines and other computer controlled events. Requires two output channels for start/stop and clear controls. All necessary parts included. Special design case $3.75

Full ½" Litronix Jumbo Dual Digit LED Displays

DL 722 - C.C.	DL 728 - C.C.
DL 721 - C.A.	DL 727 - C.A.
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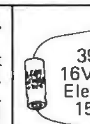
$14.95

Features: K.C. standrad 2400/1200 Hz, 300 Baud, TTL, I/O compatible, phase lock loop, 22 pin connector. Feeds serial data via microprocessors I/O ports and from cassette tape recorder. $14.95

DISC CAP ASSORTMENT * PC leads. At least 10 different values. Includes .001, .01, .05 + other standard values 60/$1.00



39 MFD 16V Mallory Electrolytic 15/$1.00 *

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COMPU/TIME offers A Real Darn Clever Enhancement to users of IMSAI/ALTAIR Microprocessors

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TIME & CALENDAR

COMPU/TIME	CT100	$199 Kit		$245 Assembled
COMPU only	C101	$149 Kit		$189 Assembled
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COMPU/TIME PC Board only				$ 80

TV-1

You will want to know about the TV-1 Video to Televisior Interface Kit.

No need to buy a separate Video Monitor if you already own a TV set. Just connect the TV-1 between your system video output and the TV set antenna terminals—that's all there is to it—to convert your TV set to a Video Monitor, and at a much lower cost!

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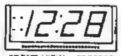
FCS 8000A — 3½ Digit — .8" Display

NEW! 25 Pin Version with colon & am/pm indicator



FRONT VIEW - FSC8000

SPECIAL $4.95 EA.

- Connects almost one for one with 3817, 3817A or D. (3817 available at $5.00 each).
- Typical segment current 8mA except colon. 10 hrs. b & c and 10 min, a & d which are 16 mA
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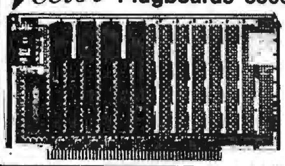
Vector Plugboards 8800V



Universal Microcomputer/ Processor plugboard, use with S-100 bus complete with heat sink & hardware 5.3 x 10 x 1/16"

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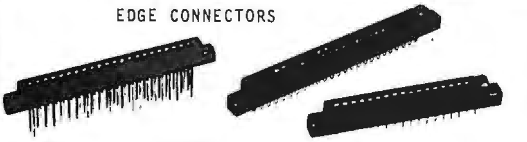
0813 — Blackjack (1 or 2 players)
0814 — Spitfire (1 or 2 players)
0815 — Spacewar (2 players)
0818 — Magic Numbers (computer logic)
0819 — Drag strip (1 or 2 players)
0820 — Maze (2 players)
0822 — Baseball (2 players)

EDGE CONNECTORS



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CD4024	1 50	CD4081	45	74C164	3 25
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74LS08	29	74LS83	1 75	74LS163	2 25
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74LS20	29	74LS92	1 25	74LS190	2 85
74LS26	39	74LS93	1 25	74LS191	2 85
74LS27	39	74LS95	1 95	74LS192	2 85
74LS28	39	74LS96	1 89	74LS193	2 85
74LS30	29	74LS107	59	74LS194	1 89
74LS32	39	74LS109	59	74LS195	1 89
74LS40	39	74LS112	59	74LS257	1 75
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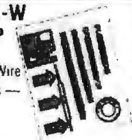

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Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
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ASSEMBLED & TESTED

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—with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

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XR-4202P	Programmable Quad Operational Amplifier	$3.60
XR-4212CP	Quad Operational Amplifier	$2.05
XR-4558CP	Dual Operational Amplifier	$0.86
XR-4739CP	Dual Low-Noise Operational Amplifier	$1.15
TIMING CIRCUITS		
XR-320P	Timing Circuit	$1.52
XR-555CP	Timing Circuit	$1.07
XR-556CP	Dual 555 Timing Circuit	$1.82
XR-2240CP	Programmable Timing Circuit	$3.44
XR-2556CP	Dual 555 Timing Circuit	$3.20
INTERFACE CIRCUITS		
XR-2200CP	Hammer Driver	$1.17
XR-2201CP/ 2202CP/2203 CP/2204CP	High Voltage, High Current Darlington Transistor Arrays	$2.25 ea
XR-2271CP	Flourescent Display Drivers	$1.15
OTHER CIRCUITS		
XR-1310P	FM Stereo Demodulator	$3.20
XR-2264CP	Proportional Servo IC	$4.24
XR-4151CP	Voltage-To-Frequency Converter	$7.50

ADVANCED MICRO DEVICES, INC

AMD

COMPUTER INTERFACE CIRCUITS

	1–9	10 UP		1–9	10 UP
MH0026CN	$2.60	$2.20	DM8820N	$2.20	$1.75
DS0056CN	5.85	4.70	DM8820AN	2.95	2.35
DS3603N	4.10	3.30	DM8830N	2.95	2.35
AM1488PC	2.10	1.85	DM8831N	3.25	2.80
AM1489PC	2.10	1.85	DM8837N	3.25	2.80
AM1489APC	2.10	1.85	DS8838N	2.95	2.35
P3212	4.35	3.75	N8T26B	3.10	2.70
P3216	3.90	3.15	P8212	4.35	3.75
P3226	3.90	3.15	P8216	3.90	3.15
DS3604N	6.85	5.35	AM8224PC	6.50	5.40
SN7521N	1.40	1.25	P8228	3.90	3.15
SN7524N	1.50	1.35	AM8228PC	8.70	7.10
SN7525N	1.40	1.25	AM8238PC	8.70	7.10
SN75107BN	2.58	2.06	9600PC	1.65	1.50
SN75108BN	2.58	2.06	9601PC	1.65	1.30
SN75109N	2.58	2.06	9602PC	1.90	1.65
SN75110N	2.58	2.06	9614PC	2.15	1.80
SN75234N	1.55	1.40	9615PC	2.15	1.80
SN75235N	1.10	1.00	9616PC	3.15	2.60
SN75238N	1.95	1.60	9617PC	2.15	1.80
SN75239N	1.50	1.25	9620PC	3.00	2.50
SN75325N	2.80	2.35	9621PC	3.00	2.50

2900 SERIES
BI POLAR MICROPROCESSOR AND SUPPORT CIRCUITS

	1–9	10 UP		1–9	10 UP
AM2901APC	$22.00	$17.40	[illegible]	$5.65	$4.50
AM2901DC	28.40	22.05	[illegible]	5.65	4.50
AM2902PC	3.82	3.18	[illegible]	5.65	4.50
AM2905PC	8.10	7.00	[illegible]	5.65	4.50
AM2906PC	11.70	8.95	[illegible]	15.75	12.60
AM2907PC	7.15	6.20	[illegible]	15.75	12.60
AM2909PC	8.95	7.15	[illegible]	6.00	4.70
AM2911PC	5.85	4.75	[illegible]	5.00	4.20
AM2913PC	4.10	3.15	[illegible]	4.50	3.60
AM2914DC	60.00	45.00	[illegible]	4.50	3.60
AM2915APC	8.10	7.00	[illegible]	6.80	5.50
AM2916APC	11.20	8.95	[illegible]	8.00	6.50
AM2917APC	7.15	8.70	[illegible]	7.55	5.95
AM2918PC	5.40	4.37	[illegible]	4.85	3.90
AM2922PC	5.78	4.93			

BIPOLAR MEMORY

	1–9	10 UP		1–9	10 UP
[illegible]	$5.00	$4.20	P3101	$4.40	$3.50
[illegible]	5.00	4.20	P3101A	4.75	3.70
[illegible]	5.65	4.50	IM5501CPE	4.40	3.50
[illegible]	5.65	4.50	MM6560N	4.40	3.50
[illegible]	4.50	3.60	MM6561N	4.40	3.50
[illegible]	4.50	3.60	DM8599N	3.38	2.80
[illegible]	8.80	6.90	82S25PC	4.75	4.20
[illegible]	8.80	6.50	93403PC	5.25	4.20

SILICON GATE MOS LSI

	1–9	10 UP		1–9	10 UP
MK1002L	$7.00	$6.00	AM2805HC	$3.70	$3.56
P1101A	4.05	3.75	AM2806HC	7.00	5.60
1402APC	4.42	2.75	AM2807PC	2.82	2.34
1403APC	4.42	2.90	AM2808PC	5.02	4.02
1404APC	4.42	2.75	AM2809PC	3.57	2.82
1405A	5.80	4.35	AM2857PC	7.15	5.75
1406	10.20	8.40	AM2896PC	5.00	4.50
1407	10.20	8.40	TMS3114NC	9.98	7.32
1506	4.05	3.24	TMS3133NC	10.85	4.02
1507	4.05	3.24	3341APC	8.25	6.55
C1702A	18.38	13.48	3347PC	6.40	5.10
P2101	2.85	2.40	MM4026D	73.00	58.40
P2101-1	4.20	3.40	MM4026D	73.00	58.40
P2101-2	4.20	3.40	MM4027D	75.00	60.00
P2101A	4.75	3.85	MM4055D	16.00	12.80
P2101A-2	5.50	4.50	MM4058H	11.50	9.20
P2102	2.30	1.80	MM4057D	16.00	12.80
P2102-1	3.45	2.80	MK4102P	21.60	18.00
P2111	2.50	2.00	C4702A	18.30	13.85
P2111-1	3.70	3.00	MM5025N	40.80	33.50
P2112	2.50	2.00	MM5026D	44.00	35.20
P2112-2	3.70	3.00	MM5027N	40.80	33.60
P2401	24.00	17.55	MM5055N	7.15	5.75
P2405	10.85	7.90	MM5056N	7.15	5.75
2505K	3.70	3.56	MM5057N	7.15	5.75
2512K	4.30	4.05	MM5058N	10.85	8.70
2521V	2.65	2.56	P8080A	18.60	15.85
2524V	2.50	2.78	AM8080APC	18.60	15.85
2525V	3.85	3.69	P8101	2.95	2.40
2533V	4.90	4.02	P8102	2.30	1.80
2602B	4.10	3.85	P8111	2.50	2.00
AM2802PC	4.42	2.75	P8261	12.50	11.50
AM2803PC	4.42	3.84	P8255	12.50	11.50
AM2804PC	4.42	2.75	C8702A	18.30	13.85
			AM9401PC	16.88	13.50

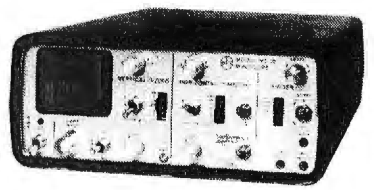
ZENER DIODES

½ WATT	V	PRICE
IN5223B	2.7	.22
IN5224B	2.8	.22
IN5225B	3.0	.22
IN5226B	3.3	.22
IN5227B	3.6	.22
IN5228B	3.9	.22
IN5229B	4.3	.22
IN5230B	4.7	.22
IN5231B	5.1	.22
IN5232B	5.6	.22
IN5233B	6.0	.22
IN5234B	6.2	.22
IN5235B	6.8	.22
IN5236B	7.5	.22
IN5237B	8.2	.22
IN5238B	8.7	.22
IN5239B	9.1	.22
IN5240B	10	.22
IN5241B	11	.22
IN5242B	12	.22
IN5243B	13	.22
IN5244B	14	.22
IN5245B	15	.22
IN5246B	16	.22
IN5247B	17	.22
IN5248B	18	.22
IN5249B	19	.22
IN5250B	20	.22
IN5251B	22	.22
IN5252B	24	.22
IN5253B	25	.22
IN5254B	27	.22
IN5255B	28	.22
IN5256B	30	.22
IN5257B	33	.22
IN5258B	36	.22
IN5259B	39	.22
IN5260B	43	.22
IN5261B	47	.22
IN5262B	51	.22
IN5263B	56	.22
IN5264B	60	.22
IN5265B	62	.22
IN5266B	68	.22
IN5267B	75	.22

1 WATT	V	PRICE
IN4728A	3.3	.44
IN4729A	3.6	.44
IN4730A	3.9	.44
IN4731A	4.3	.44
IN4732A	4.7	.44
IN4733A	5.1	.44
IN4734A	5.6	.44
IN4735A	6.2	.44
IN4736A	6.8	.44
IN4737A	7.5	.44
IN4738A	8.2	.44
IN4739A	9.1	.44
IN4740A	10	.44
IN4741A	11	.44
IN4742A	12	.44
IN4743A	13	.44
IN4744A	15	.44
IN4745A	16	.44
IN4746A	18	.44
IN4747A	20	.44
IN4748A	22	.44
IN4749A	24	.44
IN4750A	27	.44
IN4751A	30	.44
IN4752A	33	.44
IN4753A	36	.44
IN4754A	39	.44
IN4755A	43	.44
IN4756A	47	.44
IN4757A	51	.44
IN4758A	56	.44
IN4759A	62	.44
IN4760A	68	.44
IN4761A	75	.44

NON-LINEAR SYSTEMS, INC.

PORTABLE 15 MHz OSCILLOSCOPE



The MS-15 miniscope is only 2.7" x 6.4" x 7.5", and weighs only 3 lbs. Vertical bandwidth is 15 MHz. The graticuled rectangular viewing area is four divisions high by five divisions wide. Division spacing is 0.25 inches. Internal and external triggering, automatic and line synchronization modes, and a horizontal input are provided. There are 12 vertical gain settings from 0.01 V to 50 V per division, and twenty one time base settings from 0.1 μs to 0.5 s per division. An optional 10 to 1 probe and a carrying case are also available. Power is provided by batteries or the 115 V, 60 Hz line.

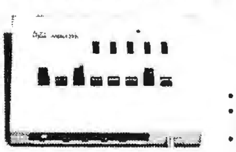
MS-15	MINISCOPE	$289.00
41-140	CARRYING CASE	30.00
41-141	10 TO 1 PROBE	24.50

ANCRONA

ALWAYS FIRST QUALITY COMPONENTS

PARATRONICS

Logic Analyzer Kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble – comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

MODEL 100A $229.00/Kit
$295.00/Assembled

TRIGGER EXPANDER KIT – Model 10
Adds 16 additional Bits – Connects direct to Model 100A (Optional baseplate permits mounting to 100A for integrated unit) (Baseplate – $12.00)

Model 10 – $229.00/Kit – $295.00/Assembled

3 TERMINAL ADJUSTABLE VOLTAGE REGULATOR

- Output adjustable between 1.2 and 37 volts
- Output current in excess of 1.5 amps
- Floating operation for high voltages
- 0.1% line and load regulation
- Full overload protection
- High-reliability, hermetically-sealed package

LM317H (TO-39)	$3.45
LM317K (TO-3)	$3.70

DUAL TRACKING REGULATOR

This circuit is a dual polarity tracking regulator designed to provide balanced positive and negative output voltages at currents up to 100 mA. It is internally set for positive and negative 15 volt outputs but a single external adjustment can be used to change both outputs simultaneously from 10 to 23 volts. This device can be used with input voltages up to + and –30 volts and also has provision for adjustable current limiting, and utilization at currents in excess of 2 amps with the aid of external power transistors.

SILICON GENERAL

	1–24	25 UP	100 UP
SG4501J	$4.45	$3.55	$2.95

MICROPOWER OPERATIONAL AMP

- Adjustable power consumption to less than 20 microwatts
- Supply voltages from ±0.75 to ±18 volts
- Less than 15 nA bias currents
- Complete short-circuit protection
- Internally compensated

	1–24	25 UP	100 UP
SG3250T	$4.90	$3.90	$3.25
SG3250M	$4.50	$3.10	$2.55

REGULATING PULSE WIDTH MODULATOR

A new monolithic integrated circuit which contains all the control circuitry for a regulating power supply converter or switching regulator. Included in this 16-pin dual-in-line package is the voltage reference, error amplifier, oscillator, pulse width modulator, pulse steering flip-flop, dual alternating output switches, and current limiting and shutdown circuitry. This device can be used for switching regulators of either polarity, transformer coupled DC to DC converters, transformer-less voltage doublers and polarity converters, as well as other power control applications.

	1–24	25 UP	100 UP
SG 3524J	$10.15	$8.10	$6.75

AVAILABLE THROUGH MAIL ORDER ONLY

SPECIALS FOR NOVEMBER

.125 Dia RED LED XC209-H 11 for $1.00

MONSANTO – 7 SEGMENT DISPLAYS
MAN 71A 1.50 MAN 73A 1.50

7400 N SERIES TTL

	1–9	10 UP		1–9	10 UP		1–9	10 UP
SN 7400N	$.16	$.12	SN 7474N	$.31	$.25	SN 74160N	$1.20	$1.10
SN 7402N	.21	.15	SN 7483N	.69	.54	SN 74161N	.99	.95
SN 7404N	.18	.17	SN 7486N	.38	.30	SN 74162N	1.80	1.70
SN 7407N	.29	.23	SN 7489N	2.40	1.95	SN 74163N	.99	.80
SN 7408N	.25	.19	SN 7490N	.44	.37	SN 74164N	1.10	.90
SN 7410N	.18	.14	SN 7493N	.49	.40	SN 74165N	1.10	.90
SN 7411N	.27	.24	SN 7495N	.79	.64	SN 74166N	1.25	.99
SN 7413N	.45	.35	SN 74100N	1.00	.79	SN 74170N	2.00	1.85
SN 7414N	.70	.55	SN 74104N	.50	.49	SN 74173N	1.50	1.18
SN 7416N	.35	.27	SN 74105N	.90	.89	SN 74174N	1.20	.95
SN 7417N	.35	.27	SN 74107N	.38	.31	SN 74175N	.99	.80
SN 7420N	.21	.16	SN 74109N	.56	.54	SN 74177N	.90	.70
SN 7425N	.29	.22	SN 74121N	.39	.31	SN 74178N	1.30	1.20
SN 7427N	.26	.20	SN 74123N	.49	.39	SN 74180N	.98	.90
SN 7432N	.31	.24	SN 74125N	.59	.47	SN 74181N	2.40	1.90
SN 7437N	.27	.20	SN 74126N	.54	.47	SN 74182N	.94	.90
SN 7438N	.27	.20	SN 74128N	.98	.56	SN 74184N	1.90	1.80
SN 7442N	.58	.46	SN 74132N	1.08	.88	SN 74192N	.89	.80
SN 7445N	.74	.60	SN 74143N	4.50	3.55	SN 74193N	.89	.80
SN 7446N	.80	.72	SN 74145N	1.15	.90	SN 74194N	1.20	1.00
SN 7450N	.22	.18	SN 74148N	1.70	1.55	SN 74195N	.75	.70
SN 7451N	.22	.18	SN 74150N	1.00	.79	SN 74196N	1.25	.95
SN 7453N	.22	.18	SN 74152N	1.10	1.05	SN 74198N	1.70	1.30
SN 7454N	.20	.15	SN 74153N	.88	.70	SN 74199N	1.70	1.30
SN 7460N	.20	.15	SN 74154N	1.00	.79	SN 74200N	5.50	5.40
SN 7470N	.45	.35	SN 74155N	.98	.78	SN 74251N	1.78	1.70
SN 7472N	.39	.30	SN 74157N	.98	.78	SN 74279N	.85	.70
SN 7473N	.36	.29	SN 74158N	1.30	1.10	SN 74367N	.74	.70

CMOS 7 SEGMENT DECODER/ DRIVER LATCH

Again for military and commercial display applications. The 4311B offers hexadecimal code while the 4511B offers decimal code. They are pin-for-pin compatible.

	1–24	25 UP
MD4311BE	$2.80	$1.76
MD4511BE	$2.80	$1.76

CMOS ALARM CIRCUIT

- 9 Volt operation
- Internal Zener reference
- Mosfet differential input (10^{15} Ω .01 pA to 60°C)
- Mode control for DC or AC horn output operation
- Audio tone output
- On-chip LED driver
- Stand-by current drain less than 25 μA
- Horn driver on-chip
- On-chip low-battery warning
- Alarm trigger input and output for cascaded operation
- Alarm indicator memory circuit
- On-chip audio oscillator
- 14 lead dual in-line package

	1–24	25 UP
MD4301BE	$2.50	$1.80

MITEL

CMOS 7 SEGMENT LCD DECODER/DRIVER

Suitable for military and commercial LCD applications. These devices offer level-shifting on-chip, permiting the input voltage swings to be different from the 7-segment output signal swings. The 4056B adds an input latch circuit to the 4055B device. Std. 16-pin packages.

	1–24	25 UP
MD4055BE	$1.87	$1.58
MD4056BE	$1.87	$1.58

CMOS 7 SEGMENT LCD DECODER/DRIVER/LATCH

For military and commercial displays, especially designed for use in microprocessor applications. A direct replacement for the TTL 9368 device, but dissipates about 25 nw instead of 500 mw at 5 volts. The 4368B will operate from 3V to 18V while each output segment can source over 25 mA of current at 5V to directly drive LED, LCD, incandescent, flourescent or gasdischarge displays. Hexadecimal code format.

	1–24	25 UP
MD4368BE	$2.80	$1.76

★ E-Z-HOOK ★

E-Z Hooks have been designed and field tested through the industry to save time and money in commercial electronic production and servicing. The spring-loaded hook attaches firmly, yet so gently it will not damage component — frees hands while testing. Durably constructed and fully insulated to a single contact point assuring true readings. Meets exacting laboratory and space age computer technology requirements. AVAILABLE IN 10 RETMA COLORS: Red, black, blue, green, oragne, yellow, white, violet, brown or gray.

MICRO HOOK

XM Micro Hook (1.75" long <1 gram) for difficult IC Testing. Permits hookups to delicate wires where weight and leverage may damage component .. $.85 ea

Specify color. ORDER P/N XM

Jumper with XM Micro Hooks

Order No.	Length	Price
204XM 12*	12"	$1.80
204XM-24*	24"	$1.80

Specify color

XM-S MICRO HOOK SET (Includes 1 ea. red, black, blue, green, orange, yellow, white, brown, violet and gray Micro Hook). At this low price you can afford more than one set.

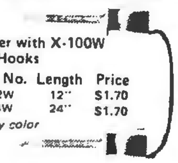
COMPLETE SET (10) MICRO HOOKS $8.45

MINI HOOK

X100W Mini Hook (2.25" long) combines rugged construction, miniature size and Finger-eze Hypo Action for all the best test connections. Hook is large enough for component leads, yet small enough to get into tight places .. $.80 ea

Specify color ORDER P/N X100W

Jumper with X-100W Mini Hooks



Order No.	Length	Price
204 12W	12"	$1.70
204-24W	24"	$1.70

Specify color

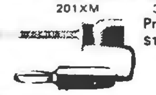
Jumper X-100W Mini Hook to Stacking Banana Plug

Order No.	Length	Price
201W	32"	$1.45

Specify color.

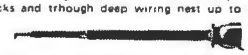
Jumper with X-100W Mini Hook

Order No.	Length	Price
201XM	32"	$1.50



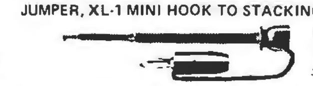
EXTRA LONG MINI HOOK

XL-1 Mini Hook (5.0" long) combines all the proven features of the X100W with an extra long body. It will make safe, short-free test connections in card racks and through deep wiring nest up to 4" .. ORDER P/N XL-1



Specify color. $1.30

JUMPER, XL-1 MINI HOOK TO STACKING BANANA PLUG



Order No.	Length	Price
201XL 1	32'	$2.05

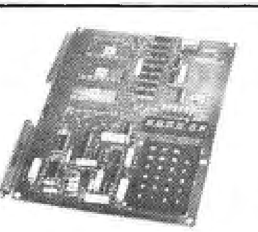
Specify color.

RCA COSMAC MICROPROCESSOR Integrated Circuits

4–6 Volt Operating Range

CDP1802CD	COSMAC CPU	$19.95	CDP1824CD	32 x 8 Static CMOS Ram	$7.75
CDP1821CD	1024 x 1 Static CMOS Ram	14.75	CDP1852CD	Byte I/O Port	8.25
CDP1822CD	256 x 4 Static CMOS Ram	15.50	CDP1856CD	Bus Separator/Buffer (Memory)	5.50
			CDP1857CD	Bus Separator/Buffer (I/O)	5.50

KIM-1 MICROCOMPUTOR

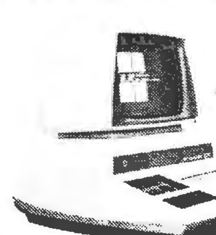


KIM-1—Computor Module from MOS Technology. 1K RAM, 2K ROM containing system executive, complete audio cassett interface, 15 bidirectional I/O lines, a 24 key keyboard and a six-digit LED display.

Documentation—KIM-1 Users Manual 6500 Hardware Manual, and 6500 Programming Manual.

Fully Assembled Fully Tested — Only $245.00

QUITE PORTABLE VERY AFFORDABLE AND UNBELIEVABLY VERSATILE the PET computer may very well be a lifetime investment



PET MODEL 2001

SPECIFICATIONS

DIMENSIONS LWD 18-1/2 x 16-1/2 x 14
WEIGHT 44 lbs

MEMORY

RAM (user) 4K (8K OPT) exp to 32K
ROM (resident operating system) 14K
8K-BASIC interpreter
4K-Operating system
1K-Diagnostic routine
1K-Machine language monitor

VIDEO DISPLAY UNIT

9" b&w high resolution CRT • 1000 char display 40 col by 25 lines • 8x8 dot matrix for characters and continuous graphics • Auto scrolling from bottom of screen • Winking cursor with full motion control • Reverse field on all characters • 64 standard ASCU char; 64 graphic char.

KEYBOARD

9-1/2" wide x 3" deep, 73 keys • All 64 ASCU characters available without shift • Calculator style numeric key pad • All 64 graphic and reverse field characters accessible from keyboard (with shift) Screen: Control Clear and erase • Editing: Character insertion and deletion

CASSETTE STORAGE

Fast redundant recording scheme assuring reliable data recovery • Modified drive for higher reliability of recording and record retention • High noise immunity, error detection and correction • Uses standard audio cassette tapes • Tape files named.

OPERATING SYSTEM

Supports multiple languages • Machine language accessibility • File management in operating system • Cursor control, reverse field and graphics under simple BASIC control • Cassette file management from BASIC • True random number generation or pseudo random sequence.

INPUT/OUTPUT

INPUT/OUTPUT

All other I/O supported through IEEE-488 instrument interface which allows for multiple intelligent peripherals • All I/O automatically managed by operating system software • Single character I/O with GET command • Easy screen line-edit capability • Flexible I/O structure allows for BASIC expansion with intelligent peripherals.

BASIC INTERPRETER

Expanded 8K BASIC • Upward expansion from current popular BASIC language • Strings, integers and multi-dim arrays • High-precision (10 significant digits) • Direct memory access through PEEK and POKE commands

ALLOW 60 TO 90 DAYS DELIVERY

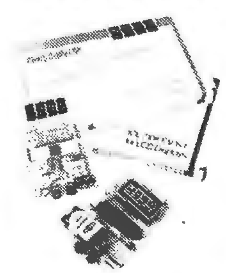
PET MODEL 2001

$595.00 with 4K RAM

$795.00 with 8K RAM

Intersil 3½ DIGIT PANEL METER

LCD or LED KITS



BUILD A WORKING DPM IN 1/2 HOUR WITH THESE COMPLETE EVALUATION KITS

Test these new parts for yourself with Intersil's low cost prototyping kits, complete with A/D converter and LCD display (for the 7106) or LED display (for the 7107). Kits provide all materials, including PC board, for a functioning panel meter.

ICL7106EV (LCD) $29.95 **ICL7107 (LED) $24.95**

CAPACITORS

50V CERAMIC DISC $1.00 Per Package

5pf	9/pkg	300pf	7/pkg	.0047mfd	9/pkg
15pf	9/pkg	330pf	7/pkg	.005mfd	9/pkg
25pf	9/pkg	390pf	7/pkg	.01mfd	9/pkg
27pf	9/pkg	470pf	7/pkg	.015mfd	8/pkg
47pf	8/pkg	560pf	7/pkg	.02mfd	8/pkg
68pf	8/pkg	680pf	7/pkg	.022mfd	8/pkg
100pf	8/pkg	.001mfd	9/pkg	.03mfd	8/pkg
150pf	8/pkg	.0015mfd	9/pkg	.039mfd	7/pkg
220pf	8/pkg	.0022mfd	9/pkg	.047mfd	7/pkg
270pf	7/pkg	.003mfd	9/pkg	.1mfd	6/pkg

PLESSEY POLYESTER MINI BOX

MF	V	S	MF	V	S	MF	V	S
001	1000	14	.012	630	14	15	100	.20
0012	1000	14	015	400	15	18	100	.21
0015	1000	14	018	400	15	22	100	.23
0018	1000	14	022	400	15	27	100	26
0022	1000	14	027	400	15	33	100	30
0027	1000	14	033	250	15	39	100	33
.0033	1000	14	039	250	15	.47	100	.36
0039	630	14	047	250	15	55	100	44
0047	630	.14	056	250	15	.68	100	.47
.0056	630	.14	.068	250	15	82	100	.54
0068	630	.14	082	250	17	1.0	100	60
.0082	630	14	1	100	17			
01	630	14	12	100	18			

MATSUO DIPPED TANTALUM

MF	V	$	MF	V	$	MF	V	$
1	35	33	2 2	20	33	10 0	35	90
15	35	33	2 2	35	40	15 0	20	45
22	35	33	3 3	35	42	15 0	35	1.32
33	35	33	4 7	35	45	22 0	16	45
47	35	33	6.8	16	40	33.0	20	1.32
68	35	33	6.8	35	45	47 0	20	1.53
1 0	35	33	10 0	16	45	68 0	16	1.62
1 5	35	40	10 0	25	45			

1% MICA 500V

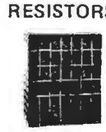
51 PF	29	220 PF	41	1500 PF	.60
62 PF	29	240 PF	46	2000 PF	.90
75 PF	29	300 PF	.50	2200 PF	.94
82 PF	.29	390 PF	.50	4700 PF	1.80
100 PF	.30	470 PF	.50	5100 PF	1.80
120 PF	32	620 PF	52	10000 PF	3.60
150 PF	.35	820 PF	.53		
180 PF	41	1000 PF	.60		

ALUMINUM ELECTROLYTIC (RADIAL LEAD)

MF	V	$	MF	V	$	MF	V	$	MF	V	$	MF	V	$
1	10	12	10	16	15	33	25	22	100	35	30	330	50	55
1	16	13	10	25	18	33	35	24	100	50	35	470	10	35
1	25	14	10	35	22	33	50	30	220	10	23	470	16	40
1	35	15	10	50	26	47	10	17	220	16	25	470	25	45
1	50	16	22	10	15	47	16	18	220	25	35	470	35	60
5	10	13	22	16	16	47	25	24	220	35	40	470	50	80
5	16	14	22	25	21	47	35	25	220	50	50	1000	25	65
5	25	17	22	35	23	47	50	32	330	10	30	1000	35	80
5	35	20	22	50	28	100	10	18	330	16	33	1000	50	1 20
5	50	24	33	10	16	100	16	20	330	25	40	2200	25	1 30
10	10	14	33	16	17	100	25	26	330	35	45	2200	35	1 60
												2200	50	2 50

QUALITY PARTS

RESISTOR KITS 5% CARBON FILM RESISTORS



COMPLETE WITH STORAGE BIN

1/4 WATT KIT
42 Different Values
(68Ω to 4.7 MΩ)
20 Each Value

1/2 WATT KIT
42 Different Values
(68Ω to 4.7 MΩ)
20 Each Value

1/4W — $24.90 PER KIT
1/2W $25.90 PER KIT

CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)

¼W . . . $1.69 per 100
½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1 1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1 3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1 8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2 4K	24K	240K	2.4M
27	270	2 7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3 3M
36	360	3 6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3 9M
43	430	4 3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5 1K	51K	510K	5 1M
56	560	5.6K	56K	560K	5.5M
62	620	6 2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7 5K	75K	750K	7.5M
82	820	8 2K	82K	820K	8.2M
91	910	9 1K	91K	910K	9 1M

RESISTOR ASSORTMENTS

Each assortment contains 5 pcs each of 10 different values
Values included are shown in (Ohms)
¼W,5% (50 pcs total). . .$1.75 / ½W,5% (50 pcs total). . .$1.85

Asst.1. 10 12. 15. 18. 22 27 33. 39. 47 56 ohm
Asst.2. 68 82 100. 120. 150 180. 220. 270. 330. 390 ohm
Asst.3. 470 560, 680, 820 ohm, 1K 1 2K, 1 5K 1 8K 2 2K 2 7K
Asst 4. 3 3K 3 9K, 4 7K, 5 6K 6 8K 8 2K, 10K, 12K 15K, 18K
Asst.5 22K 27K 33K 39K 47K 56K 68K 82K, 100K 120K
Asst.6 150K, 180K 220K 270K 330K 390K, 470K 560K 680K 820K
Asst 7. 1M 1 2M 1 5M 1 8M 2 2M 2 7M 3 3M 3 9M 4 7M 5 6M
(½W Assortment No 7 doesn't include 5 6M)
Asst 8R (All seven assortments above)
¼W 5% 350 pcs total $10.95 ½W 5% 350 pcs total $11.55

Sanken HYBRID AUDIO POWER AMPLIFIERS

SOCKET FOR SANKEN AUDIO AMPLIFIERS

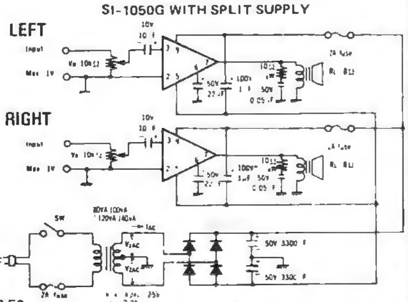
SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi, stereo, musical instruments, public address systems and other audio applications. The amplifiers have quasi-complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength. Built-in current limiting is provided for SI-1050G and all devices can be operated from a single or split power supply.

- SI-1010G (10W output) . . . $ 6.90
- SI-1020G (20W output) . . . $13.95
- SI-1030G (30W output) . . . $19.00
- SI-1050G (50W output) . . . $27.80

Data Sheet with Application Notes — $0.50

- Multi-purpose linear amplifiers for comercial and industrial applicacations.
- Less than 0.5% harmonic distortion at full power level.
- 1/2 dB response from 20 to 100,000 Hz.
- Single or split (dual) power supply.
- Rugged, compact and lightweight packages
- Built-in current limiting for SI-1050G and efficient heat radiating construction.

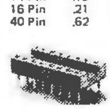
TYPICAL CONNECTIONS
SI-1050G WITH SPLIT SUPPLY



DIP SOCKETS

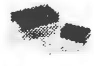
LOW PROFILE SOLDER TIN

	1-24	25-49	50 UP
8 Pin	.16	.15	.14
14 Pin	.19	.18	.17
16 Pin	.21	.20	.19
40 Pin	.62	.61	.60



STANDARD SOLDER GOLD

8 Pin	.30	.27	.24
14 Pin	.35	.32	.29
16 Pin	.38	.35	.32
40 Pin	1.75	1.59	1.45



WIREWRAP GOLD (Level No. 3)

14 Pin	.39	.38	.37
16 Pin	.43	.42	.41

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7400 TTL

7400 .18	7442 1.08	74107 .49			
7401 .21	7448 1.15	74121 .55			
7402 .21	7450 .26	74122 .49			
7404 .21	7451 .27	74123 1.05			
7405 .24	7453 .27	74125 .60			
7407 .45	7454 .41	74126 .81			
7408 .25	7460 .22	74132 3.00			
7409 .25	7472 .39	74141 1.15			
7410 .20	7473 .45	74150 1.10			
7411 .30	7474 .45	74151 1.25			
7413 .85	7475 .80	74153 1.35			
7416 .43	7482 1.75	74154 1.54			
7417 .43	7483 1.15	74157 1.30			
7420 .21	7485 1.12	74161 1.45			
7422 1.50	7486 .45	74164 1.65			
7425 .43	7489 2.49	74165 1.65			
7427 .37	7490 .69	74166 1.70			
7428 .35	7491 1.20	74174 1.95			
7430 .26	7492 .82	74175 1.95			
7432 .31	7493 .82	74180 1.05			
7437 .47	7494 .91	74181 3.55			
7438 .40	7495 .91	74191 1.50			
7440 .21	7496 .91	74195 1.00			
7441 1.10	74100 1.25	74197 1.00			

74L SERIES TTL

74L00	.33	74LS04	.45	74LS113	.98
74L10	.33	74LS10	.39	74LS138	1.89
74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

74H00 TTL

74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
74H10	.33	74H40	.33	74H76	.65

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MC663P	2.50	MC1460	3.95
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MC725P	1.50	MC1510G	8.00
MC789P	1.50	MC1514L	4.50
MC790P	1.50	MC1595L	6.25
MC817P	1.30	MC1723CL	3.60
MC836P	1.35	MC1741CG	1.20
MC844	1.25	MC1810P	1.25
MC853P	2.25	MC3004L	2.25
MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
MC1439	2.65	MC14511CP	2.76
MC1458P	.50	MC14512CP	1.70

C MOS

4001AE	.29	4023AE	.29
4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
4021AE	1.50		

LINEAR

75450BP	.49	LM301H	.35	LM741CH	.45
75451BP	.39	LM307H	.35	LM747	.90
75452BP	.39	LM309K	1.25	LM748H	.45
75453BP	.39	LM311H	.90	LM1458N	.80
75454BP	.39	LM318N	1.50	N5556V	1.50
75491BP	.79	LM339N	1.65	NE5558	1.00
75492BP	.85	LM351AN	.65	NE555V	.60
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3026	1.50	LM723H	.75	UA749CH	.45
CA3046	.35	LM741CN	.45		

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LM340K-18	1.95
LM340K-24	1.95
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LM340T0-6	1.75
LM340T0-8	1.75
LM340T0-12	1.75
LM340T0-15	1.75
LM340T0-18	1.75
LM340T0-24	1.75

RESISTORS

¼ Watt ± 5% Packed 5 of any one value .... $.25

½ Watt ± 5% Packed 5 of any one value .... $.30

STANDARD RESISTANCE VALUES

JAPANESE TRANSISTORS

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2SA484	3.00	2SC374	.70	2SC777	4.00	2SC1307	5.75	2SD187	.80		
2SA489	.80	2SC375	.65	2SC778	4.00	2SC1308	4.75	2SD188	.95		
2SA495	1.65	2SC380	.70	2SC781	3.00	2SC1317	.60	2SD201	1.95		
2SA496	1.15	2SC381	.70	2SC784	.70	2SC1318	.70	2SD213	3.75		
2SA497	1.00	2SC382	.70	2SC785	1.00	2SC1327	.70	2SD218	4.75		
2SA562	.70	2SC387	.70	2SC788	2.15	2SC1342	.50	2SD223	4.50		
2SA564	.50	2SC394	.70	2SC789	1.00	2SC1347	.80	2SD234	1.00		
2SA606	4.25	2SC403	.65	2SC790	1.75	2SC1359	.65	2SD235	1.00		
2SA628	.65	2SC454	.65	2SC793	2.50	2SC1377	5.50	2SD257	2.00		
2SA634	1.25	2SC458	.70	2SC798	3.10	2SC1382	1.00	2SD261	.80		
2SA636	1.25	2SC460	.70	2SC799	3.50	2SC1383	.75	2SD287	4.00		
2SA643	.85	2SC478	.80	2SC815	.75	2SC1384	.85	2SD288	1.00		
2SA673	.85	2SC481	1.85	2SC821	4.00	2SC1447	1.25	2SD291	.85		
2SA678	.75	2SC482	1.75	2SC828	.75	2SC1448	1.25	2SD300	2.50		
2SA679	3.75	2SC484	3.75	2SC829	.75	2SC1449	1.30	2SD313	1.10		
2SA680	3.75	2SC485	3.25	2SC830	1.60	2SC1475	1.50	2SD314	1.10		
2SA682	.85	2SC493	2.75	2SC838	.70	2SC1507	1.25	2SD315	.75		
2SA683	.90	2SC494	3.50	2SC839	.85	2SC1569	1.25	2SD318	.95		
2SA684	.95	2SC495	1.10	2SC853	1.00	2SC1675	1.75	2SD325	1.25		
2SA699	1.30	2SC496	1.15	2SC866	5.85	2SC1678	5.50	2SD330	1.50		
2SA699A	1.45	2SC497	1.60	2SC871	.70	2SC1679	4.75	2SD331	.90		
2SA706	.55	2SC502	1.50	2SC900	.70	2SC1728	2.15	2SD350	3.25		
2SA733	.65	2SC509	1.25	2SC922	.55	2SC1730	.60	2SD360	1.50		
2SA777	.90	2SC515	.80	2SC929	.70	2SC1756	1.25	2SCF8	3.50		
2SB22	.65	2SC517	4.25	2SC930	.65	2SC1760	2.15	2SCF6	1.25		
2SB54	.70	2SC535	.75	2SC938	.65	2SC1818	4.50	2SF8	3.00		
2SB56	.70	2SC536	.65	2SC945	.65	2SC1908	.70	HEPS3001	3.25		
2SB77	.70	2SC537	.70	2SC1000	.65	2SC1909	4.75	JSP7001	.75		
2SB175	.55	2SC608	4.90	2SC1013	1.50	2SC1957	1.50	MRF8004	3.00		
2SB186	.60	2SC609	4.90	2SC1014	1.50	2SC1964	4.75	MPS8000	1.25		
2SB187	.60	2SC614	3.80	2SC1017	1.50	2SC1973	1.50	MPS8001	1.25		
2SB324	1.00	2SC619	.70	2SC1018	1.50	2SC1974	4.90	MPSU02	.50		
2SB337	1.75	2SC620	.80	2SC1034	3.50	2SC1975	4.90	MPSU31	4.00		
2SB367	1.60	2SC627	1.75	2SC1060	.75	2SC2020	2.50	SD1074	19.95		
2SB370	.65	2SC634A	.65	2SC1061	1.65	2SC2027	6.00	SD1076	28.95		
2SB405	.85	2SC644	.70	2SC1079	3.75	2SC2028	1.10	SK3047	3.75		
2SB407	1.65	2SC674	.60	2SC1080	3.75	2SC2029	4.75	SK3048	3.25		
2SB415	.85	2SC708	3.00	2SC1096	1.20	2SC2034	3.00	SK3049	4.75		
2SB435	.75	2SC710	.70	2SC1098	1.15	2SC2074	3.00	SK3054	1.25		
2SB461	1.25	2SC711	.70	2SC1115	2.75	2SC2075	5.50	2SK19	1.75		
2SB463	1.65	2SC712	.70	2SC1116	4.00	2SC2091	1.10	2SK30A	1.00		
2SB474	1.50	2SC715	.70	2SC1124	1.25	2SC2092	4.75	2SK33	1.20		
2SB481	2.10	2SC730	.65	2SC1166	.70	2SC2166	4.75	2SK41	1.75		
2SB492	1.25	2SC731	3.00	2SC1170	4.00	2SD45	2.00	3SK22Y	2.75		
2SB495	.95	2SC732	.70	2SC1172	4.00	2SD68	.90	3SK40	2.75		
2SB507	.90	2SC733	.70	2SC1172B	4.25	2SD72	1.00	3SK45	2.75		
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3.3MF10	No Polarity	.15	47MF50	Radial Leads	.24
10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
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AN208	4.75	LA4051P	4.65	TA7061P	2.25	UPC20C	5.00
AN210	3.10	LA4400FS	3.80	TA7063P	2.25	UPC41C	3.95
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AN214	4.90	LD3080	4.00	TA7075P	4.90	UPC554C	3.90
AN217	3.30	LD3120	3.10	TA7076P	4.55	UPC555H	3.00
AN227	5.80	M5112	5.40	TA7089P	2.90	UPC563H2	8.00
AN239	6.50	M5115PR	4.80	TA7120P	2.20	UPC566H	2.25
AN241	3.20	PLL01A	13.50	TA7120P-C	2.20	UPC575C	4.10
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AN315	3.60	PLL02A-G	12.00	TA7124P	1.85	UPC592H2	3.00
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1N270	.25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20		
1N914	.10	2N1560	2.80	2N2904	.25	2N3416	.19	2N3904	.16	2N4410	.16		
1N4148	.25	2N1605	1.75	2N2904A	.30	2N3417	.20	2N3905	.16	2N4416	.75		
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00		
		2N1711	.50	2N2905A	.30	2N3553	1.50	2N3954A	3.75	2N4442	1.15		
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35		
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55		
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30		
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50		
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20		
2N706	.25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15		
2N718	.25	2N2219A	.30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15		
2N718A	.30	2N2221	.25	2N3053	.30	2N3731	3.75	2N4141	.16	2N5294	.50		
2N918	.60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50		
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61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
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- 1000 ohms per volt

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BARREL KIT #210 GLOWIN' PANELS 3 for $1.98. 4" x 1" panels that glow blue-green with 110VAC. Use for nite lites, indicators, etc. Cat. No. 12E3550

BARREL KIT #76 1-WATT ZENERS 100 for $1.98. Untested. Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V, under glass. Double plug. 12E2741

BARREL KIT #188 400 PARTS $1.98. Includes resistors, caps, diodes, IC's, for PC work, some on PC boards. Dumped into barrels by factories, 100% material. Wt. 12 ozs. Cat. No. 12E3401

BARREL KIT #184 ¼-WATT METAL FILM 150 for $1.98. 100% metal film resistors. Long leads. 12E3413

BARREL KIT #182 JUMBO RED LEDS 15 for $1.98. 100% material, user cancellation from factory dumps, 3V 10 mils. For 100's of projects, red lens. Cat. No. 12E3369

BARREL KIT #163 MINI TRIM POTS 30 for $1.98. 1 oz. Asst. values 100 to 1 meg. What a buy. Single turn, ¼ W. Wt. 6 oz. 12E3345

BARREL KIT #160 HOBBY VOLTAGE REGULATORS 10 for $1.98. LM-309K TO-3 barreled, bot by the pound, but who wants to check 'em? Your gain. Wt. 20 ozs. 12E3330

BARREL KIT #138 PANEL SWITCHES 30 for $1.98. 9 ozs. Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 12E3268

BARREL KIT #128 MINI-DIP IC'S 100 for $1.98. 741's, LM380, 703, 567, 555, who knows? Factory mixed, you test. Untested and hobby. Wt. 1 lb. Cat. No. 12E3245

BARREL KIT #127 AXIAL ELECTROS 40 for $1.98. Asst. capacities and voltages. Cat. No. 12E1227

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98. 1mf to 300mf in mixture of voltages. 100% marked 'n good. 12E3226

BARREL KIT #115 MOLEX SOCKETS 150 for $1.98. 100% good. Cat. No. 12E3144. Calculator maker dump! We got a zillion of 'em.

BARREL KIT #109 TERMINAL STRIPS 100 for $1.98. Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat. No. 12E3136

BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98. Cat. No. 12E3057

BARREL KIT #101 RESISTOR SPECIAL 200 for $1.98. Includes: ⅛, ¼, ½, 1, 2-watters, carbon. 8 oz. 100% good. 12E3054

BARREL KIT #99 PHOTO ELECTRIC CELLS 10 for $1.98. Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat. No. 12E3052

BARREL KIT #93 HALF WATTERS 200 for $1.98. Resistor factory tried to fool us by mixing 100% color-coded resistors in barrel. But value is there. 4 oz. 12E3046 Untested

BARREL KIT #87 NAT. IC BONANZA! 100 for $1.98. Hobby and untested, factory mixed in barrels. Linears, 7400's, ROMS, DTL'S, registers, clock and calculator chips and more. Wt. 12 ozs. Cat. No. 12E2860

BARREL KIT #86 HOBBY LEDS 40 for $1.98. WOW! Top U.S.A. maker dumps discretes in barrels. Hobby and untested. Useable yield 50% or better! Wt. 4 ozs. Cat. No. 12E2859

BARREL KIT #83 LM-340T VOLTAGE REGULATORS 15 for $1.98. Factory rejects, hobby, cosmetic rejects. May include 5, 6, 12, 15, 18 or 24 volts, TO-220 power tab. Wt. 4 ozs. Cat. No. 12E2635

BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98. micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good Cat. No. 12E2738

BARREL KIT #68 2 WATTERS 100 for $1.98. 100% good. Suppliers throw 'em in the barrel. It's a li'l gold mine. All marked Cat. No. 12E2735

BARREL KIT #61 POLYSTYRENE CAPS 100 for $1.98. Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat. No. 12E2729

BARREL KIT #58 SLIDE SWITCHES 30 for $1.98. All shapes, sizes, spst, dpdt, momentaries, etc. Tremendous shop pak for 100's of switching projects. Cat. No. 12E2726 100% good

BARREL KIT #39 HOBBY NPN POWER TRANSISTORS 15 for $1.98. Factory fallouts and "off spec" TO-3 powers. 100% hobby, no opens, no shorts. Wt. 1 lb. Cat. No. 12E2617

BARREL KIT #31 METALLIC RESISTORS 100 for $1.98. Made mostly by Corning, the finest resistor made. Mostly ½ watters, 1% to 5% tol. & a barrel of values. Cat. No. 12E3609

BARREL KIT #30 PREFORMED RESISTORS 200 for $1.98. We got barrels of ¼ and ½ watters for pc use. 100: ¼, 100: ½ watters. No. 12E2608 100% good

BARREL KIT #27 PREFORMED DISCS 150 for $1.98. Hi-Fi mfr's shelf inventory but he dumped 'em in barrels. Preformed, for PC use. Mixed values too! 12E2605

BARREL KIT #26 PLASTIC TRANSISTORS 100 for $1.98. Untested and hobby transistors, TO-92 (TO-18), asst. 2N numbers, asst. manufacturers. Wt. 8 ozs. 12E2604

BARREL KIT #20 LONG LEAD DISCS 100 for $1.98. "auction sale" Prime, marked only. Long leads. Cat. 12E2598 100% good

BARREL KIT #19 DIPPED MYLARS 60 for $1.98. Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat. No. 12E2597 100% good

BARREL KIT #14 PRECISION RESISTORS 200 for $1.98. Marked and unmarked ¼, ½, 2 watts. No. 12E2428

BARREL KIT #7 VOLUME CONTROL 30 for $1.98. 100% good. Singles, duals, variety of values, styles, big ones — small ones. Cat. 12E2421

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98. Imagine famous switching diodes at these prices! Cat. No. 12E2418 Untested.

BARREL KIT #1 SN7400 DIP IC'S 75 for $1.98. Marked 14 and 16 pin dips, may include gates, flip-flops, registers, counters, who knows? Untested, hobby. Wt. 14 ozs. 12E2415

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.

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SALE — Send for FREE SPRING CATALOG

C.O.D.'s MAY BE PHONED

MINIMUM ORDER — $6.00

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY2.01	2.010 MHz	HC33/U	$1.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

BREAD BOARD JUMPER WIRE KIT

Each kit contains 350 wires cut to 14 different lengths from 0.1" to 5.0".
Each wire is stripped and the leads are bent 90° for easy insertion.
Wire length is classified by color coding.
All wire is solid tinned 22 gauge with PVC insulation.
The wires come packed in a convenient plastic box.

JK1 . . . . $10.00 / kit

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out
Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100	PINS (Wire Wrap)	$6.95
50/100A (.100 Spacing)	PINS (Wire Wrap)	$6.95

25 PIN-D SUBMINIATURE

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

HEAT SINKS

205-CB 680-.75A

205-CB	Beryllium Copper w-black finish for T0-5	$ .25
291-.36H	Aluminum for T0-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum for T0-3	$1.60
Dude 4	Black Anodized Aluminum — predrilled mounting holes for T0-3 — 4¾ x 1¼ x 2"	$1.75

DIP SWITCHES SPST Slide Action

#206-4 (8 pin dip) 4 switch unit $1.75 ea.
#206-7 (14 pin dip) 7 switch unit $1.95 ea.
#206-8 (16 pin dip) 8 switch unit $2.25 ea.

Etching Kits (cannot be shipped via air)

32 X A-1 —— P.C Etch Materials Kit enough for 5 circuit boards — $29.95 ea.
27 X A-1 —— Etched Circuit Kit Complete kit — only add water — $ 9.95 ea.

Plugboards

3662 —— 6.5 X 4.5 X 1/16 Epoxy glass P-Pattern-44 P.C. Tabs-spaced .156 — $ 6.95 ea.
22/44 —— Mating connector for plugboard — 22 pin double readout — $ 2.95 ea.
8800V —— Universal Microcomputer/Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5.313 x 10 x 1/16 copper clad — $19.95 ea.

Vector

1/16 VECTOR BOARD

0.1 Hole Spacing

	Part No	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

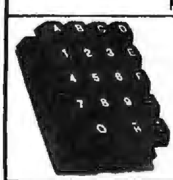
Vector

SLIT-N-WRAP WIRE WRAP TOOL

- Slits and opens insulation exposing bare wire
- No pre-cutting or pre-stripping.
- Comes complete with two - 100 ft spools #28 AWG wire

Model P180 $24.50

HEXADECIMAL ENCODER 19-KEY PAD



- 1 - 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

63 KEY KEYBOARD $29.95

This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very sturdy molded plastic 13" x 4" base suits most applications.

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

TOOLS

A97MS	— Diagonal Cutter - 4" semi-flush cut	$7.95 ea.
A11DMS	— Chain Nose Pliers - 4¾" long	7.50 ea.
T-6	— Wire Stripper - #16 to #26 gauge	3.75 ea.
55B	— Wire Stripper - #10 to #20 gauge	2.50 ea.
CS-8	— Cutter-Crimper Tool - 8¼" long	7.95 ea.
Nibbing Tool	— Cuts, Trims or Notches Metal up to #18 gauge	6.95 ea.
Nibbling Tool Replacement Punch		3.75 ea.

PERMACEL® P-29 PLUS Electrical Tape - All Weather
• ¾" wide x 66 ft. • Black vinyl
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MICROPROCESSOR COMPONENTS

8080A	CPU	$16.00	CDP1802	CPU	$19.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	24.95
8214	Priority Interrupt Control	15.95	MC6820	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	9.95	MC6830L8	1024 x.8 Bit ROM	15.00
8228	System Controller Bus Driver	10.95	Z80	CPU	29.95

CPU'S

8080A	Super 8008	16.00
2650	8 Bit MPU	26.50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	1.95
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513(2140)	Char Gen -upper case	$ 9.95
2513(3021)	Char Gen -lower case	9.95
2516	Char Gen	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107 5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	1.49
21L02/91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	2 for 1.00
UPD414(2104)4K		Dynamic 16 Pin	5.95

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	[illegible]
74S…	[illegible]	Static	[illegible]
3601	256 x 4	Fast	3.95
2708	8K	Eprom	19.95
2716	16K	Eprom	34.95
6301-1	1024	Tri-State Bipolar	3.49
6330 1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	MCM6575	17.50	9368	3.95
AY-3-8500-1	8.95	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	17.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	17.50	DS0026CH	3.75	MC1408L8	9.95
82S115	25.00	7205	19.95	TIL308	10.50		

CLOCK CHIPS

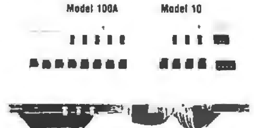
MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



Model 100A Model 10

- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

• Some applications are.
— Troubleshooting microprocessor address, instruction, and data flow
— Examine contents of ROMS
— Tracing operation of control logic
— Checking counter and shift register operation
— Monitoring I/O sequences
— Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit).

Model 10 — $229.00
Baseplate — $6.95

B&K PRECISION

3½-Digit Portable DMM

- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0.1 ohm resolution
- Overrange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4 x 4.4 x 2"

Model 2800
$99.95
Comes with test leads, operating manual and spare fuse

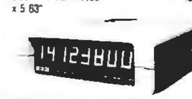
Accessories:
AC Adapter BC-28 8.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 6.00

CSC

100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

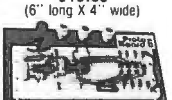


ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100	- 4.5" x 6"	$ 19.95
PB101	- 5.8" x 4.5"	29.95
PB102	- 7" x 4.5"	39.95
PB103	- 9" x 6"	59.95
PB104	- 9.5" x 8"	79.95
PB203	- 9.75 x 6½ x 2¾	80.00
PB203A	- 9.75 x 6½ x 2¾ (includes power supply)	129.95

LOGIC MONITOR

for DTL, HTL, TTL or CMOS Devices $84.95

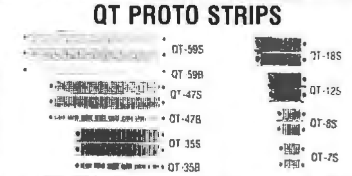
PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

Experimentor 300	$ 9.95
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Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
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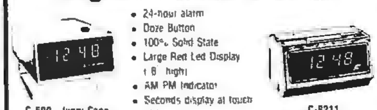
All Advertised Prices Good Thru December

Timeband

Digital Alarm Clocks



- 24-hour alarm
- Doze Button
- 100% Solid State
- Large Red Led Display (.8" high)
- AM PM Indicator
- Seconds display at touch of button
- Power failure indicator
- One year factory warranty

C-500 - Ivory Case
C-500B - Ebony Case
$16.95

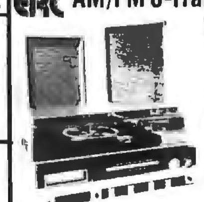
C-8211
Woodgrain Case
$19.95

Timeband by FAIRCHILD LAMP CLOCK

- 24 hour alarm
- Doze button
- Alarm-on indicator
- .8" high Red LED Display
- AM/PM Indicator
- High intensity lamp
- Lamp shuts off when collapsed

Model C-590 (Ivory) $29.95

ERC AM/FM 8-Track Stereo Receiver With BSR Changer



- PLL System
- BSR Record Changer
- Slide Controls
- Automatic AFC Control
- 4 Speaker Output
- Walnut finish vinyl covered wood veneer with smoke dust cover

Size: 20"W x 9⅜"H x 15¼"D

Model 8365 $149.95

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One
- Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model 311D-5C-5V Power Kit $17.50

JE700 CLOCK

The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

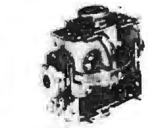
12 or 24 Hour

115 VAC

KIT ONLY $16.95

JOYSTICK

These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Study metal construction with plastic components only at the movable joint. Perfect for electronic games and instrumentation.



100K	$5.95
5K	$4.95

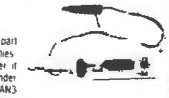
INSTRUMENT/CLOCK CASE

Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

$3.95 ea.

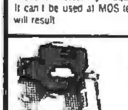
JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL DTL RTL CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



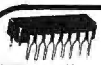
$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

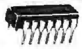


This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package including the hardware for only

$9.95 Per Kit



7400N TTL



SN7400N	16	SN7472N	39	SN74160N	1 25
SN7401N	18	SN7473N	.39	SN74161N	99
SN7402N	.20	SN7474N	.35	SN74162N	1.95
SN7403N	.20	SN7475N	.50	SN74163N	99
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SN7405N	20	SN7479N	5.00	SN74165N	99
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SN7407N	35	SN7482N	.99	SN74167N	3.25
SN7408N	.20	SN7483N	.70	SN74170N	2.10
SN7409N	.25	SN7485N	.89	SN74172N	8.00
SN7410N	20	SN7486N	.39	SN74173N	1 50
SN7411N	30	SN7488N	3.50	SN74174N	1.25
SN7412N	.35	SN7489N	2.49	SN74175N	99
SN7413N	69	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	75	SN74177N	79
SN7416N	.35	SN7492N	49	SN74179N	2.49
SN7417N	35	SN7493N	49	SN74180N	.99
SN7420N	.20	SN7494N	79	SN74181N	2.49
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SN7429N	42	SN74116N	1 95	SN74190N	1 79
SN7430N	.25	SN74121N	39	SN74191N	1 25
SN7432N	.25	SN74122N	39	SN74192N	89
SN7437N	25	SN74123N	50	SN74193N	.89
SN7438N	35	SN74125N	.60	SN74194N	1 25
SN7439N	.25	SN74126N	60	SN74195N	75
SN7440N	.21	SN74132N	1.25	SN74196N	1 00
SN7441N	89	SN74136N	95	SN74197N	1 00
SN7442N	69	SN74141N	1 15	SN74198N	1.75
SN7443N	75	SN74142N	2.95	SN74199N	1 75
SN7444N	75	SN74143N	3.25	SN74200N	5 59
SN7445N	75	SN74144N	3.00	SN74251N	1 79
SN7446N	.69	SN74145N	1 15	SN74279N	.90
SN7447N	.69	SN74147N	2.35	SN74283N	2.25
SN7448N	89	SN74148N	2 00	SN74284N	5.00
SN7450N	.25	SN74150N	1.25	SN74285N	6.00
SN7451N	.25	SN74151N	79	SN74365N	.75
SN7453N	.25	SN74153N	.89	SN74366N	.75
SN7454N	.25	SN74154N	1.25	SN74367N	.75
SN7459A	.25	SN74155N	89	*SN74368N	75
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LM308H	1 00	78MG	1 75	LM748N	.39
LM308CN	1 00	LM370N	1 15	LM1303N	.90
LM309H	1 10	LM373N	3.25	LM1304N	1 19
LM309K	1 25	LM377N	4 00	LM1305N	1 40
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LM340K-6	1.35	LM709N	.29	75453CN	39
LM340K-8	1 35	LM710N	79	75454CN	39
LM340K-12	1 35	LM711N	39	75491CN	79
LM340K-15	1 35	LM723H	.55	75492CN	.89
LM340K-18	1 35	LM723N	55	75494CN	89
LM340K-24	1 35	LM733N	1 00	RC4194	5.95
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LM340T-6	1 25				

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74LS00	.29			74LS155	1.25
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74LS03	29	74LS75	69	74LS160	1.95
74LS04	35	74LS76	.49	74LS161	1 95
74LS05	.35	74LS83	1 75	74LS162	1 95
74LS08	29	74LS85	2.49	74LS163	1 95
74LS10	29	74LS86	49	74LS164	1 95
74LS13	69	74LS90	89	74LS175	1 95
74LS14	1 75	74LS92	89	74LS181	3.69
74LS20	.29	74LS93	.89	74LS190	2 49
74LS26	39	74LS95	1 50	74LS191	2 49
74LS27	39	74LS96	1 89	74LS192	2.49
74LS28	39	74LS107	.59	74LS193	2.49
74LS30	29	74LS109	.59	74LS194	1 89
74LS32	39	74LS112	59	74LS195	1 89
74LS40	29	74LS123	1 25	74LS253	1.75
74LS42	1 25	74LS132	1 25	74LS257	1 75
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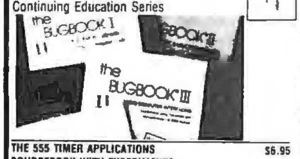

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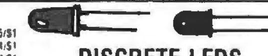

.125" dia			.190" dia.		
XC209	Red	5/$1	XC111	Red	10/$1
XC209	Green	4/$1	XC111	Green	4 $1
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XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	¼ x ¼ x 1 16
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DISPLAY LEDS

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MAN 1	Common Anode-red	270	2.95	MAN 6630	Common Anode-orange	560	1 25
MAN 2	5 x 7 Dot Matrix-red	300	4.95	MAN 6640	Common Cathode-orange-D D	560	1 25
MAN 3	Common Cathode-red	125	39	MAN 6650	Common Cathode-orange ±1	560	1.25
MAN 4	Common Cathode-red	187	1 95	MAN 6660	Common Anode-orange	560	1.25
MAN 7	Common Anode-red	270	1.25	MAN 6680	Common Cathode-orange	560	1.25
MAN 7G	Common Anode-green	270	1.95	MAN 6710	Common Anode-red-D.D	.560	1.25
MAN 7Y	Common Anode-yellow	270	1 95	MAN 6730	Common Anode-red-D D	560	1,25
MAN 52	Common Anode-green	.300	1.00	MAN 6740	Common Cathode-red-D D	560	1.25
MAN 71	Common Anode-red	300	1 25	MAN 6750	Common Cathode-red ±1	560	1.25
MAN 72	Common Anode-red	.300	1 25	MAN 6760	Common Anode-red	560	1.25
MAN 74	Common Cathode-red	300	1 50	MAN 6780	Common Cathode-red	560	1 25
MAN 81	Common Anode-yellow	300	1 00	DL701	Common Anode-red ±1	300	1.00
MAN 82	Common Anode-yellow	300	1 00	DL702	Common Cathode-red	300	1 25
MAN 84	Common Cathode-yellow	300	1 00	DL704	Common Cathode-red	300	1.50
MAN 3620	Common Anode-orange	300	1 00	DL707	Common Anode red	300	1.50
MAN 3630	Common Anode-orange ±1	300	1 35	DL741	Common Anode-red	600	1 95
MAN 3640	Common Cathode-orange	300	1.75	DL746	Common Anode-red ±1	.630	1.95
MAN 4610	Common Anode-orange	.300	1 00	DL747	Common Anode-red	600	2.25
MAN 4640	Common Cathode-orange	400	1.00	DL749	Common Cathode-red ±1	630	1.95
MAN 4710	Common Anode-red ±1	.400	1 00	DL750	Common Cathode-red	600	2.49
MAN 4730	Common Anode-red	400	1.00	DL338	Common Cathode-red	110	69
MAN 4740	Common Cathode-red	400	1 00	FND70	Common Cathode (FND359)	250	75
MAN 4810	Common Anode-yellow	400	1.00	FND503	Common Cathode (FND500)	500	1.29
MAN 6610	Common Anode-orange-D D	560	1.25	FND507	Common Anode (FND510)	500	1 29

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CA3023	2.56	CA3083	1 60
CA3035	2.48	CA3086	85
CA3039	1 35	CA3089	3 75
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CA3053	1 50	CA3102	2.95
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STEREO DECODERS		XR 1488	5 80	XR 2556CP	3 20
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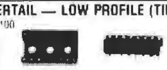
XR-1310EP	3 20	XR 2208	5 20	**PHASE LOCKED LOOPS**	
XR-1800P	3 20			XR 210	5 20
XR-2567	2 99			XR 215	6 60
				XR 567CP	1 95
				XR 567CT	1 70

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS



	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$ 17	16	15	24 pin	$ 38	37	36
14 pin	20	19	18	28 pin	45	44	43
16 pin	22	21	20	36 pin	60	59	58
18 pin	29	28	27	40 pin	63	62	61
22 pin	37	36	35				

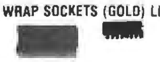
SOLDERTAIL STANDARD (TIN)

14 pin	$ 27	25	24	28 pin	$ 99	90	81
16 pin	30	27	25	36 pin	1 39	1 26	1 15
18 pin	35	32	30	40 pin	1 59	1 45	1 30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$ 30	27	24	24 pin	$ 70	63	57
14 pin	35	32	29	28 pin	1 10	1 00	90
16 pin	38	35	32	36 pin	1 75	1 40	1 26
18 pin	52	47	43	40 pin	1 75	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



8 pin	$.40	38	35	22 pin	95	85	.75
10 pin	45	41	37	24 pin	$1 05	95	85
14 pin	39	38	37	28 pin	1 40	1 25	1 10
16 pin	43	42	41	36 pin	1 59	1 45	1 30
18 pin	75	68	62	40 pin	1 75	1 55	1 40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	1/4 WATT 5%	50 PCS
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	1/4 WATT 5%	50 PCS
ASST. 3	5 ea	470 OHM / 2K	560 OHM / 1 5K	680 OHM / 1 8K	820 OHM / 2 2K	1K / 2 7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea	3 3K / 8 2K	3 9K / 10K	4 7K / 12K	5 6K / 15K	6 8K / 18K	1/4 WATT 5%	50 PCS
ASST. 5	5 ea	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	1/4 WATT 5%	50 PCS
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	1/4 WATT 5%	50 PCS
ASST. 7	5 ea	1M / 2 7M	1 2M / 3 3M	1 5M / 3 9M	1 8M / 4 7M	2 2M / 5 6M	1/4 WATT 5%	50 PCS.

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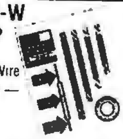
- Complete with built-in bit and sleeve

WIRE-WRAP KIT — WK-2-W



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- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

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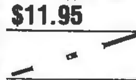

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WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft $15.00
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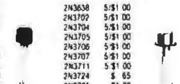
TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1 00	1N4005	600 PIV	1 AMP	10/1 00
1N751A	5 1	400m	4/1 00	1N4006	800 PIV	1 AMP	10/1 00
1N752	5.6	400m	4/1 00	1N4007	1000 PIV	1 AMP	10/1 00
1N753	6 2	400m	4/1 00	1N3600	50	200m	6/1 00
1N754	6 8	400m	4/1 00	1N4148	75	10m	15/1 00
1N959	8 2	400m	8/1 00	1N4154	35	10m	12/1 00
1N965B	15	400m	4/1 00	1N4305	75	25m	20/1 00
1N5232	5 6	500m	28	1N4734	5 6	1w	28
1N5234	6 2	500m	28	1N4735	6 2	1w	28
1N5235	6.8	500m	28	1N4736	6 8	1w	28
1N5236	7 5	500m	28	1N4738	8 2	1w	28
1N456	25	40m	6/1 00	1N4742	12	1w	28
1N458	150	7m	6/1 00	1N4744	15	1w	28
1N485A	180	10m	6/1 00	1N1183	50 PIV	35 AMP	1 60
1N4001	50 PIV	1 AMP	12/1 00	1N1184	100 PIV	35 AMP	1 70
1N4002	100 PIV	1 AMP	12/1 00	1N1185	150 PIV	35 AMP	1 50
1N4003	200 PIV	1 AMP	12/1 00	1N1186	200 PIV	35 AMP	1 80
1N4004	400 PIV	1 AMP	12/1 00	1N1188	400 PIV	35 AMP	3 00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1 95
C38M	35A @ 200V	SCR	1 95
2N2328	1 6A @ 200V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS



MPS A05	5/$1 00	2N3638	5/$1 00	PN4250	4/$1 00
MPS A06	5/$1 00	2N3702	5/$1 00	2N4400	4/$1 00
2N918	4/$1 00	2N3704	5/$1 00	2N4401	4/$1 00
2N2219A	3/$1 00	2N3705	5/$1 00	2N4402	4/$1 00
2N2221	4/$1 00	2N3706	5/$1 00	2N4403	4/$1 00
2N2222A	5/$1 00	2N3707	5/$1 00	2N4409	5/$1 00
2N2369	5/$1 00	2N3711	5/$1 00	2N5086	4/$1 00
2N2369A	4/$1 00	2N3724	$ 65	2N5087	4/$1 00
2N2484	4/$1 00	2N3725	$1 00	2N5088	4/$1 00
2N2906A	4/$1 00	2N3772	$2 25	2N5089	4/$1 00
2N2907A	5/$1 00	2N3903	5/$1 00	2N5129	5/$1 00
2N2925	5/$1 00	2N3904	4/$1 00	2N5138	5/$1 00
2N3035	2/$1 00	2N3905	4/$1 00	2N5139	5/$1 00
2N3055	$ 89	2N3906	4/$1 00	2N5209	5/$1 00
MJE2955	$1.25	2N4013	3/$1 00	2N5210	5/$1 00
MJE3055	$1 00	2N4014	3/$1 00	2N5432	$2 00
2N3392	5/$1 00	2N4123	6/$1 00	2N5449	3/$1 00
2N3398	5/$1 00	PN4249	4/$1 00	2N5951	5/$1 00
PN3567	3/$1 00			C106B1SCR	2/$1 00
PN3568	4/$1 00			40409	$1 75
PN3569	4/$1 00			40410	$1 75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	04	03	001µF	05	04	035
22 pf	.05	04	03	.0047µF	05	.04	.035
47 pf	.05	04	03	01µF	05	.04	.035
100 pf	.05	04	03	022µF	06	.05	04
220 pf	05	04	03	047µF	06	.05	04
470 pf	.05	04	035	1µF	12	09	075

100 VOLT MYLAR FILM CAPACITORS

001mf	12	10	.07	022mf	13	11	08
0022	12	10	07	047mf	21	17	13
0047mf	12	10	07	1mf	27	23	17
01mf	12	10	07	22mf	33	27	22

±20% DIPPED TANTALUMS (SOLID) CAPACITORS

1/35V	28	23	17	1 5/35V	30	26	21
15/35V	28	23	17	2 2/25V	31	27	22
22/35V	28	23	17	3 3/25V	31	27	22
33/35V	28	23	17	4 7/25V	32	28	23
47/35V	28	23	17	6 8/25V	36	31	.25
.68/35V	28	23	17	10/25V	40	35	29
1 0/35V	28	.23	17	15/25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	15	13	10	47/25V	15	13	.10
1.0/50V	16	14	11	47/50V	16	14	11
3.3/50V	15	13	10	1 0/16V	15	13	10
4.7/25V	16	14	12	1 0/25V	16	14	.11
10/25V	15	.13	10	1.0/50V	16	14	11
10/50V	16	14	12	4.7/16V	.15	13	10
22/25V	.17	15	12	4 7/25V	.15	13	10
22/50V	24	.20	18	4 7/50V	16	14	.11
47/25V	19	17	15	10/16V	14	12	.09
47/50V	25	.21	19	10/25V	15	13	10
100/25V	24	.20	18	10/50V	16	14	12
100/50V	35	30	28	47/50V	24	21	.19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	.41	38	100/25V	.24	.20	18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	.45	220/16V	23	17	16
2200/16V	70	62	.55	470/25V	.31	28	.26

CIRCLE NO. 29 ON FREE INFORMATION CARD

OPERATION ASSIST

(Continued from page 128)

schematic and/or instruction manual. Bruce Crain, 307 Meadow Ln., Sewickley, PA 15143.

Movic Stereo One tape recorder. Schematic and service manual. John R. Carp, 19606 S. Albert Ave., Cerritos, CA 90701.

Superior Instruments Model TW-11 tube checker. Schematic and tube chart. Howard E. Sykes, 2909 W. Paris St., Tampa, FL 33614.

E.H. Scott Model SLRF shortwave radio, Serial No. 512. Circa 1930's. Need any available information. Al Stiles, 240 E. 35th St. (16th Flr.), New York, NY 10016.

Magnavox Model 1SC237 stereophonic record player, Chassis No. AP 8001 40. Need schematic and component information. Clinton Reed, 5911, Deering Ave., Parma Heights, OH 44130.

MDS (possibly Montgomery Data Systems) Automatic Wake-up Alarm, Assembly No. 200410A. Operation and external interfacing information needed. Also address of company if available. Edward A. Wald, 1353 Unruh Ave., Philadelphia, PA 19111.

Telerate Systems Model 72TVK2012, Serial No. 345(1183). Any available information. Thomas Serra, 31 Cleveland St., Hyde Park, MA 02136.

Sinclair Model X-20 Class-D hi-fi amplifier. Schematics and/or available information. J.M. Rice, Star Rte, Box 337, Buckingham, VA 23921.

Knight Model R55A receiver. Schematic and/or operation manual. Neil Van Oost Jr., RD #1, Box 301P, Waretown, NJ 08758.

Philco Model 47-1227 78 rpm, AM/FM. Need source of tubes, 5AZ4 and 7X7. Dick Eachus, P.O. Box B, West Point, CA 95255.

Fada Model FC 0212 stereo, Chassis No. R-825. Need

schematic. Sean A. Devitt, 2237 Wharton Rd., Glenside, PA 19038.

Atwater Kent Model 30 receiving set, Serial No. 518473. Parts source, service data and instruction manual. Edward N. Ham, 1727 26th Avenue N, St. Petersburg, FL 33713.

JBL Model SG-520 preamplifier and Model SE-400S power amplifier. Need service manuals. Jacob Landy, 11 Gardenia Ln., Hicksville, NY 11801.

Mercury Electronics Model 300 tube tester. Operating manual, schematics, parts list, and tube-socket charts. Also source of Model AD-300 adapter. **Superior Instruments** Model 82 or 82A tube tester. Any available information. Vernon Lawver, RR1, Box 85A, Rockton, IL 61072.

Tele-tone Model TV-208. Schematic, parts list, and/or manual. Barry Wilen, 7439 Prince George Rd., Baltimore, MD 21208.

Hallicrafters Model SX-71 communication receiver. Instruction manual. Also need tube, VR150 or OD3. Jeff Cherry, 603 S. Cedar, Brea, CA 92621.

C.R. Doty Model PAS ultra linear 70 amplifier and transistorized preamp. Operation and service manuals. Russ Buchheit, Lake Walton, Rd., Wappingers' Falls, NY 12590.

Hammarlund Model HQ-215 receiver. Need service information. Karl A. Williamson, D&W Electronics, Box 251, Fenton, MO 63026.

Jackson Model CRO-2 oscilloscope. Operating instructions and schematic. Howard Adams, 209 W. Shadywood Dr., Midwest City, OK 73110.

Atwater Kent Model 185A radio. Schematic and parts list. J.H. Taylor, Box 51, RD #2, Glen Mills, PA 19342.

United Cinephone Model FL-893 test oscilloscope made for U.S. Army Signal Corps. Any available information. N. Marshall, 2122 Buckingham, Lincoln Park, MI 48146.

Gonset Model G-66B receiver and Model G-77 transmitter. Need schematic, and operating and service manuals. James A. Hansatte, 802 Moondale Dr., Glenshaw, PA 15116.

Intercontinental Instruments Model PG-1 and PG-32 pulse generators. Service manual and/or schematic. Daniel Hoyt, Hall High School, West Hartford, CT 06117.

Scott Model 99-C amplifier. Operation and maintenance manuals. John Collins, 1211 W. Old Cold Spring Ln., Baltimore, MD 21209.

Zenith Model 3000-1 transoceanic FM-AM multiband receiver. Schematic and/or service manual. Douglas J. Picirillo, 452 Riverside Dr., Apt. 22, New York, NY 10027.

Browning Labs Model ON-5 oscilloscope. Circa 1958. Need wave forms and voltage-to-resistance readings. Lorne Hosking, 4722 Cape May Ave., San Diego, CA 92107.

Wurlitzer Model 2910 juke box. Service manual needed. James Chadek, 2609 River Hills Rd., Two Rivers, WI 54241.

U.S. Army Signal Corps. R-19H/TRC-1 radio receiver, Serial No. 4733. Any available information. Joe L. Hill, 1100 Jones Dr., Bowling Green, KY 42101.

Hallicrafters Model SX 100 receiver. Schematic and/or operation manual. D. Kearney, Box 193, Sta. A, Goose Bay Airport, Labrador, Canada AOP 150.

Atwater Kent Model 545-S and **Philco** Model 40-140 and 40-190 radios. Need schematics. Milton Obuch, 1308 N. 4th St., Sayre, OK 73662.

Packard Bell Model RPT-1 stereo and receiver and Model 8TU-1 tuner. Schematic and manuals needed. Dale Shulz, 9536 Schagel St., Longmont, CO 80501.

Rider radio manuals. Need volumes 23,21,20 and 17 plus indexes. Also old 4-pin radio tubes for Radiola collection. Ken Westfall, 323½ Newport Ave., Long Beach, CA 90803.

Stephens midrange loudspeaker. Need data and replacement PM unit. Sam Zumbro, RR #2, Box 672-A, Redlands, CA 92373.

Friden Model SP5 flexowriter. Any available information. Steve A. Parra, 409 Oregon Ave., Alamogordo, NM 88310.

J.H. Bunnell antique telegrapher's key and sounder, mounted on single base. Any information or history on unit or company. Philip G. Martin, 1010 Chicago St., Hammond, IN 46327.

Philco Model 7100 color bar and dot generator. Schematic and calibration information. **B&K** Model 400 cathode rejuve-

(Continued on page 149)

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7403	.15
7404	.17
7405	.18
7406	.24
7407	.24
7408	.17
7409	.17
7410	.16
7411	.20
7412	.20
7413	.25
7414	.55
7416	.22
7417	.22
7420	.16
7421	.17
7423	.28
7424	.35
7425	.25
7426	.22
7427	.17
7430	.14
7432	.23
7437	.23
7438	.21
7439	.25
7440	.14
7441	.70
7442	.40
7443	.55
7444	.55
7445	.65
7446	.62
7447	.59
7448	.60
7450	.15
7451	.17
7453	.17
7454	.17
7460	.17
7470	.27
7472	.21
7473	.21
7474	.27
7476	.28
7480	.35
7482	.50
7483	.62
7485	.75
7486	.26
7489	1.75
7490	.40
7491	.51
7492	.40
7493	.40
7494	.60
7495	.60
7496	.60
7497	3.20
74109	.32
74121	.31
74122	.38
74123	.55
74125	.38
74126	.38
74132	.65
74141	.70
74145	.65
74147	1.50
74148	1.15
74150	.88
74151	.65
74152	.65
74153	.60
74154	.95
74155	.65
74156	.65
74157	.65
74160	.83
74161	.83
74162	.83
74163	.83
74164	.90
74165	.90
74166	.95
74167	3.20
74170	1.95
74173	1.10
74174	.85
74175	.75
74176	.69
74177	.70
74178	1.25
74179	1.25
74180	.65
74181	1.75
74182	.75
74184	1.87
74185	1.87
74188	2.80
74190	.95
74191	.95
74192	.80
74193	.80
74194	.80
74195	.49
74196	.80
74197	.80
74198	1.40
74199	1.40
74251	1.00
74279	.49
74283	1.00
74290	.59
74293	.57
74298	1.20
74365	.62
74366	.62
74367	.62
74368	.62

74LS00 TTL

74LS00	0.22
74LS01	.27
74LS02	.23
74LS03	.26
74LS04	.24
74LS05	.29
74LS08	.23
74LS09	.25
74LS10	.25
74LS11	.23
74LS12	.27
74LS13	.45
74LS14	.85
74LS15	.26
74LS20	.23
74LS21	.23
74LS22	.23
74LS26	.31
74LS27	.26
74LS30	.23
74LS32	.30
74LS37	.31
74LS38	.31
74LS39	.44
74LS40	.26
74LS42	.60
74LS47	.75
74LS48	.72
74LS51	.25
74LS54	.25
74LS55	.25
74LS69	.60
74LS73	.36
74LS74	.36
74LS76	.37
74LS78	.36
74LS83	.75
74LS85	1.30
74LS86	.36
74LS90	.52
74LS92	.52
74LS93	.52
74LS95	.90
74LS107	.36
74LS109	.36
74LS112	.36
74LS113	.36
74LS114	.36
74LS123	.90
74LS125	.46
74LS126	.46
74LS132	.75
74LS133	.34
74LS136	.36
74LS138	.70
74LS139	.70
74LS151	.65
74LS152	.65
74LS153	.66
74LS154	1.00
74LS155	.62
74LS156	.62
74LS157	.62
74LS158	.70
74LS160	.82
74LS161	.82
74LS162	.82
74LS163	.82
74LS164	.98
74LS168	.83
74LS169	.83
74LS170	1.60
74LS173	1.00
74LS174	.75
74LS175	.79
74LS181	3.50
74LS190	.90
74LS191	.90
74LS192	.90
74LS193	.90
74LS194	.90
74LS195	.50
74LS196	.80
74LS197	.80
74LS221	1.75
74LS251	.80
74LS253	.80
74LS257	.80
74LS258	.70
74LS259	1.60
74LS260	.48
74LS266	.26
74LS279	.52
74LS283	.72
74LS290	.60
74LS293	.60
74LS295	.90
74LS298	1.00
74LS365	.62
74LS366	.62
74LS367	.62
74LS368	.62
74LS386	.36
74LS390	1.65
74LS393	1.35
74LS490	1.10
74LS670	2.29

74S00 TTL

74S00	0.35
74S02	.35
74S03	.35
74S04	.36
74S05	.36
74S10	.35
74S11	.38
74S15	.38
74S20	.35
74S22	.36
74S30	.27
74S32	.50
74S40	.35
74S51	.17
74S64	.38
74S65	.38
74S74	.58
74S112	.58
74S113	.58
74S114	.58
74S132	.75
74S133	.38
74S134	.38
74S135	.49
74S137	.77
74S138	.77
74S139	1.50
74S140	.47
74S151	1.25
74S153	2.10
74S157	.75
74S158	1.25
74S174	1.50
74S175	1.45
74S189	2.75
74S194	1.75
74S200	3.25
74S206	3.75
74S253	.95
74S257	1.15
74S258	1.15
74S280	2.25
74S287	3.20
74S289	3.55
74S300	1.60
74S305	1.90
74S310	2.85
74S312	1.05
74S313	1.55
74S316	2.80
74S339	3.00
74S341	4.10
74S342	1.20
74S343	4.95
74S346	1.25
74S362	2.15
74S387	4.70

74C00 TTL

74C00	0.27
74C02	.27
74C04	.29
74C08	.29
74C10	.27
74C14	1.50
74C20	.27
74C30	.27
74C32	.35
74C42	1.50
74C48	1.95
74C73	.75
74C74	.65
74C76	.95
74C83	1.50
74C85	1.20
74C86	1.45
74C89	4.40
74C90	1.10
74C93	1.10
74C95	1.30
74C107	.80
74C151	2.75
74C154	2.70
74C157	2.00
74C160	1.30
74C161	1.90
74C162	1.90
74C163	1.90
74C164	2.95
74C165	2.95
74C173	1.60
74C174	1.95
74C175	1.95
74C192	2.00
74C193	2.25
74C195	2.25
74C200	8.25
74C221	2.00
74C901	.96
74C902	.96
74C903	.96
74C904	.96
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74C906	.96
74C907	.96
74C908	2.10
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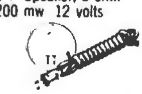

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OPERATION ASSIST

(Continued from page 147)

nator and tester. Schematic and operation information. **DeVry** Model 1S14 VTVOM. Schematic and calibration information. Dan Nelson, 541 SE 1st, Toledo, OR 97391.

Hallicrafters Model 505 television. Need source of 7JP4 picture tube. Hollis Shull, 15 S. California, Morris, MN 56267.

Navy Model OCP-4 sonar portable testing equipment. Need schematic and operation manual. Ira C. Davey, 566 Norton Pkwy, New Haven, CT 06511.

RCA Model AR77 communications receiver. Schematics and operation manual. Manny Galindo, 4 Stanton Rd., Newburgh, NY 12550.

Hamm-arlund Model HQ 150 receiver. Operation manual and schematic. Bob Sqwallesh, 414 Brunswick Rd., Fayetteville, NC 28303.

Hallicrafters Model S-38C SW receiver. Owner's manual. Irving M. Prais, 2679 Puesta del Sol, Santa Barbara, CA 93105.

General Radio Navy Surplus Model LP, type CAG-60006 radio. Need source of rectifier power unit, type CAF-60080 and schematic. Brad Sausser, Star Route, Coeur D-Alene, ID 83814.

National Radio Model NC 109. Operating instructions, alignment data and schematic. John A. Bradstreet, 404 Western Ave., Augusta, ME 04330.

Morse Electro Products Model TR-7100CC stereo unit. Operation manual. **General Electric** Model RP-1816BN-A and RP-1817BG-A record players. Wiring diagram and/or operation manual. Scott Dunsford, 209 Patterson St., Newmarket, Ontario, CAN. L3Y 3L5.

National Model SW3 shortwave receiver. Series 10–20 coils needed. M. Edelheit, 245–21 77 Crescent, Bellrose, NY 11426.

Gonset Model G-76 radio. Schematic or any available information. Dietmar May, 1590 Potomac Heights Dr., Oxon Hill, MD 20021.

Marlux Model MAX-409A 7-inch reel-to-reel tape recorder. Schematics or any available information. Don Gillard, Box 86530, North Vancouver, British Columbia, CAN.

Superior Instruments Model 82A Tube Tester. Data chart and operation manual. Wesley Garcia, 709 Locust St. #5, Pasadena, CA 91101.

Hammarlund Radio H.C. 100. Copy of tube location. George Dundas, Jr. Box 62, Metlakatla, AK 99926.

Grundig Model 3066 Multi-band receiver. Need power transformer 9078-041. L.A. Petragalla, 515 N. Federal Hwy., Deerfield Beach, FL 33441.

Fried-Eisemann Model # FE-15, No. 393E. Schematic and component information. Garry Hahn, 1788 Augusta Ct., Lexington, KY 40505.

Crosley Corp. radio receiver and transmitter BC 654-A. Schematic and service manual. Joe Wilson, 6800 Hwy. 17 East, Conniston, Ontario, P0M 1M0, CAN.

Radiobar Corp. of America, Philco 5-tube chassis — 3 band type. Schematic, tube numbers and layout. Phil Nielson, 8323 Rothesay Place, Stockton, CA 95209.

Browning Labs, Inc., Oscilloscope, Model OL-15A. Schematic or service manual. Neil Streitberger, 1460 Kensington Dr., Fullerton, CA 92631.

Bell Model 2425 AM-FM stereo receiver, serial # 120639. Need transformer #32B119. Kevin Hayden, Lot 16, 1946 Wyoming Ave., Exeter, PA 18643.

GE Model 635 portable AM radio. Service manual and schematics. Mike Tickal, Box 477, Mason City, IA 50401.

Hallicrafter Model S-38D receiver. Schematics or other information. John McNamee, 924 24, Santa Monica, CA 90403.

Harvey-Wells Model T90 Band Master transmitter. Schematic. John Tranthan, Rt. 4, Box 199, Asherville, NC 28806.

Precision Apparatus series 914 tube tester. **RCA** #156-B tube tester. Schematic, manual, tube charts. W.R. Gulliford, 714–7th Ave., Seattle, WA 98104.

Jackson oscilloscope Model CRO-2. Any information needed. Curt Palme, 990 Wavertree Rd., No. Vancouver, B.C. CAN V7R 155. ◇

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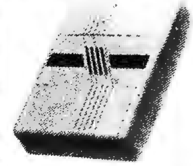

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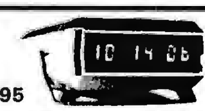

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SOLID STATE *(Continued from page 89)*

Individual LED's are driven directly by the BCD and 7-segment outputs, pins 2 to 12, through 1000-ohm, 1/2-W, current-limiting resistors. Another LED can be driven by the pulse output available at pin 20 (through a 1000-ohm resistor, of course). Low-frequency pulse signals are also available at the digit enable outputs, pins 21 to 26, and can be used to flash LED's through appropriate npn driver transistors (*Q1*), as shown by the dotted line connections. A separate driver transistor, current-limiting resistor (*R3*) and LED is required for each output. However, the transistors can be low-cost "bargain package" types, for they are used only as switches.

The multiple LED flasher can be assembled using any preferred construction technique, although Professor Bungay suggests perf board construction with *Molex* LED sockets to minimize possible heat damage from soldering, to simplify circuit changes and modification, and to permit experimentation with different color LED's. He suggests, further, that some hobbyists might wish to cluster a number of clock IC's, flashing from 50 to 100 or more LED's. The only real limits on the possible combinations and applications are one's imagination and financial resources.

Device/Product News. Imaginative experimenters will welcome a new long-delay bucket-brigade device (BBD) recently introduced by *Panasonic's Electronic Components Division* (One Panasonic Way, Secaucus, NJ 07094) and the *Matsushita Electric Corporation of Japan*. The new one-chip IC, type MN-3005, is a 4,096-stage unit that can delay an audio signal electronically for up to 205 milliseconds. Accepting input signals up to 1.3-V rms, the device has a S/N ratio of 75 dB and offers essentially 0-dB insertion loss. Supplied in a special 8-lead DIP, the MN-3005 can be used to create improved reverberation and echo effects in electronic musical instruments such as organs, music synthesizers and guitar amplifiers, and also may be used for variable or fixed analog signal delays, analog shift registers, and time compression or voice scrambling in communication systems.

Creative hobbyists should be able to have a ball dreaming up applications for the MCA-7 reflective object sensor manufactured by *Monsanto* and available through *Schweber Electronics* and other franchised industrial electronics distributors. Netting for a little under four dollars each in unit quantities, the device comprises a gallium-arsenide infrared LED and silicon photodarlington in a single package, arranged so that both are perpendicular to the face of the device. The latter permits the photodarlington to respond to light reflected by nearby objects or surfaces.

Teledyne Semiconductor (1300 Terra Bella Ave., Mountain View, CA 94043) has introduced a new low-cost voltage/frequency/voltage (V/F/V) converter which combines bipolar and CMOS technology on a single chip. Designated type 9400, the new IC is available in 14-pin plastic or ceramic DIP's. Interfacing with all logic families, the device operates from 10 Hz to 100 kHz in V/F applications, with 0.01% typical linearity to 10 kHz, supplying both pulse and square-wave outputs. In the F/V mode, the 9400 operates from dc to 100 kHz, with 0.1% typical linearity over the full range. It can be used with either single or dual power supplies, requiring only 1.6 mA. Typical applications include 13-bit A/D converters, digital panel meters, microprocessor data acquisition, analog data transmission, temperature or speed sensing and control, digital scales, and analog frequency meters. ◇

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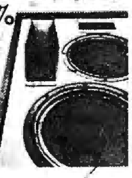

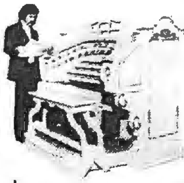

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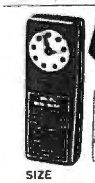

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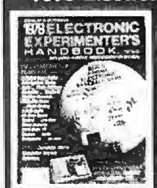

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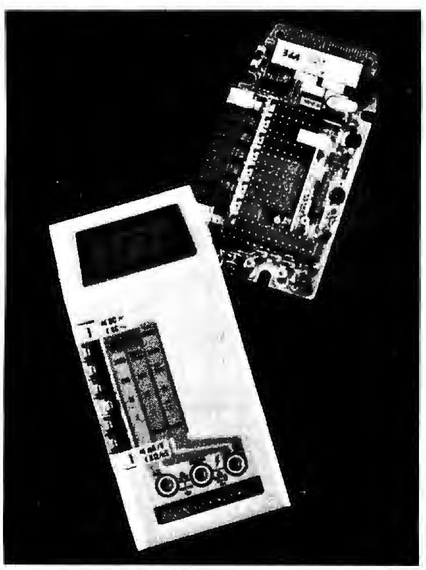

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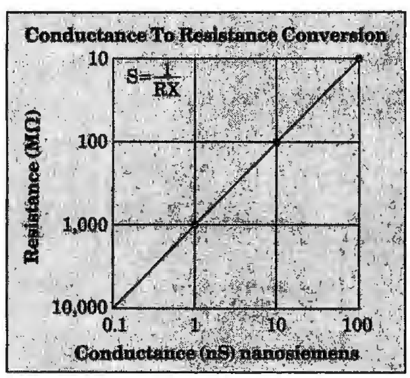
Nanosiemens?



Beginner or pro, you'll find the meter you now have can't measure nanosiemens. So what? With the 8020A *conductance* function, you can measure the equivalent of 10,000 megohms in nanosiemens. Like capacitor, circuit board and insulation leakage. And, you can check transistor gain with a simple, homemade adapter. Only with the 8020A, a 13-oz. heavyweight that goes where you go, with confidence.

What price to pay.

$169.*

Of course, you can pay more. Or less. In fact, you could pay almost as much for equally compact but more simplistic meters, and get far less versatility. And, the 8020A gives you the 'plus' of custom CMOS LSI chip design, and a minimum number of parts (47 in all). All parts and service available at more than 100 Fluke service centers, worldwide. Guaranteed, for a full year.

Rugged. Reliable. Inexpensive to own and to operate; a simple 9V battery assures continuous use for up to 200 hours.

Where to buy.

Call (800) 426-0361 toll free. Give us your chargecard number and we'll ship one to you the same day. Or, we'll tell you the location of the closest Fluke office or distributor for a personal hands-on feel for the best DMM value going.

*U.S. price only

Fluke 8020A DMM for Home Electronics Experts: $169

FLUKE®

CIRCLE NO 81 ON FREE INFORMATION CARD

Select what you want in a record cleaner.

☐ Convenience in use and storage.

You shouldn't need a separate shelf, elaborate motions or an act of Congress to clean your records. A comfortable, hand-held instrument that works best on a rotating turntable is ideal.

☐ Effectiveness against micro-dust.

Tiny, invisible dust particles hide in delicate record grooves and can be ground into the vinyl. Only a slanted (directional) fiber using special ultra-small fiber tips can scoop up, rather than rearrange, this micro-dust contamination.

☐ Effectiveness against chemical contamination.

Fingerprints and vapor-borne oils will deposit into channels of a record groove. Such contamination hides from adhesive rollers and all dry cleaning systems. Only a special fluid plus micro-fibers can safely remove such audible, impacted deposits.

☐ Total removal of contamination/fluid.

Capillary action—the lifting of fluid by small fiber surface tension—is totally effective. You want to get contamination off the record, along with any fluid traces.

☐ Lasting construction.

You want quality. A record cleaner can last a lifetime. A plastic wonder can crack into oblivion—or you can purchase the hand-rubbed elegance of milled walnut befitting the rest of your audio system.

☐ Ultimate economy.

The value of a truly fine record cleaner is justified by the cost of replacing your record collection. Fifteen dollars is a small investment in long-term protection.

☑ All of the above.

DISCWASHER, the Superior Record Cleaner.

See the finer audio dealers for a demonstration.

discwasher, inc. 1407 N. Providence Rd., Columbia, MO 65201

CIRCLE NO. 14 ON FREE INFORMATION CARD

Now... a Hide-away CB that doesn't sacrifice audio quality. From Johnson CB.

Compare Johnson's big speaker with competitive speaker in the mike.

Johnson's new remote-mounting Hide-away CB includes a full-size 2-way radio communications speaker. Others don't.

With other hide-aways you get a miniature speaker in the microphone, which delivers miniature sound. Or, you get no speaker at all. You have to hook up your CB through your car radio speaker. Either way, there's a compromise with communication audio clarity.

But the Johnson Hide-away CB is engineered and built as a system. Our voice-tailored audio circuitry is designed to drop off signals outside voice frequencies and it is matched to our communication speaker characteristics.

The CB chassis mounts out of sight in the trunk or under the seat. It has our exclusive TANL for full-time suppression of electrical noise. Plus a built-in AGC to prevent audio overload from strong, nearby stations. The result is a superb sounding CB.

The compact speaker/readout module which mounts in the passenger compartment, gives full, rich sound and some other unique advantages. We put our large LED channel display on the module, instead of the microphone to make it easier and safer to read.

And only Johnson gives you a choice between a conventional microphone, or a beautiful radiotelephone-type handset that gives you all the advantages of the conventional mike plus private listening with the flip of a switch. Both give you volume, squelch and electronic channel changing—all within a finger's reach. And our built-in amplified speech compressor circuitry delivers maximum "talk power" automatically.

So whether your transmitting or receiving, Johnson is the best-sounding hide-away you can buy. And the most reliable, too—made in America and backed by Johnson's one-year warranty with nation-wide service.

Made in U.S.A.

JOHNSON CB®

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